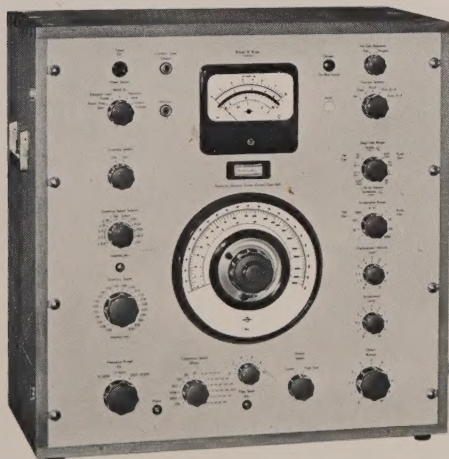


INSTRUCTIONS AND APPLICATIONS

Automatic Vibration Exciter Control Type 1025



The Automatic Vibration Exciter Control is a specially designed signal source for the vibration testing of mechanical and electro-mechanical components in the frequency range 5 Hz to 10 kHz.

Accelerometers
Acoustic Standing Wave Apparatus
Artificial Ears
Artificial Voices
Audio Frequency Response Tracers
Audio Frequency Spectrometers
Audio Frequency Vacuum-Tube Voltmeters
Automatic A.F. Response and Spectrum Recorders
Automatic Vibration-Exciter Control Generators
Band-Pass Filter Sets
Beat Frequency Oscillators
Complex Modulus Apparatus
Condenser Microphones
Deviation Bridges
Distortion Measuring Bridges
Frequency Analyzers
Frequency Measuring Bridges
Hearing Aid Test Apparatus
Heterodyne Voltmeters
Level Recorders
Megohmmeters
Microphone Accessories
Microphone Amplifiers
Microphone Calibration Apparatus
Mobile Laboratories
Noise Generators
Noise Limit Indicators
Pistonphones
Polar Diagram Recorders
Preamplifiers
Precision Sound Level Meters
Recording Paper
Strain Gage Apparatus and Accessories
Surface Roughness Meters
Variable Frequency Rejection Filters
VHF-Converters
Vibration Pick-ups
Vibration Pick-up Preamplifiers
Wide Range Vacuum Tube Voltmeters

BRÜEL & KJÆR

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Automatic Vibration Exciter Control

Type 1025

APRIL 1967

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1. Introduction

The importance of laboratory tests which can simulate the rigorous vibrations to which components and structures may be subject during service has been fully recognized. Depending on environmental conditions it is usual to choose one (or more) of the following three types of excitation for these tests; viz.

- Shock
- Random motion
- Sinusoidal motion

Whilst it is true that the first two are of great value in the fields of aeronautics and space technology, there is no doubt that the sine test, and preferably a sine test which sweeps throughout the frequency range of interest, is of most universal application. The design engineer has come to regard it as a day-to-day tool for determining the natural frequencies and Q values of resonances, and the life-test engineer uses such tests as the basis of his work.

The Automatic Vibration Exciter Control feeds a shaker table, usually via a power amplifier, and the frequency of excitation is altered by means of a built-in drive. However, owing to the uneven frequency response of the mechanical system, the power required to vibrate the test object at a given level is dependent on frequency. To keep the vibration level constant whatever the frequency, a signal measuring the motion of the shaker table is fed back to the Automatic Vibration Exciter Control. This completes a servo loop which regulates the power output of the exciter so that various predetermined test programmes can be carried out under controlled conditions.

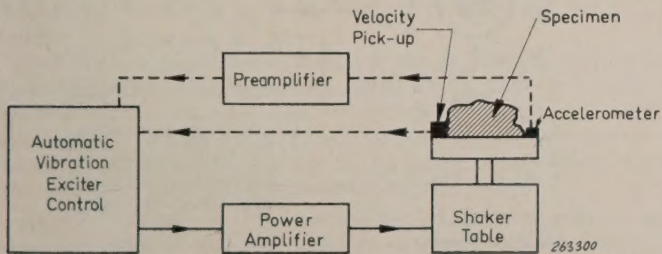


Fig. 1.1. Principle of a closed loop vibration test system. The accelerometer and velocity pick-up are alternative transducers, only the former requiring a preamplifier.

1. INTRODUCTION

Either an accelerometer or a velocity pick-up may be used as transducer and the vibration derivation section of the 1025 contains all the integrator and differentiator networks necessary for deriving acceleration, velocity, or displacement from either input. It is possible to keep any of these dynamic properties constant on the shaker table, and also there are two "auto" arrangements in which the quantity measured and controlled can be changed at a predetermined "cross-over" frequency, i.e.

displacement below cross-over to acceleration above,
or velocity below cross-over to acceleration above.

All the vibration derivatives can be read directly on the semi-logarithmic meter scale provided the velocity or acceleration signals to the inputs are scaled to 96.3 mV per inch/sec or 10 mV per g respectively. Acceleration generators should be used in conjunction with the Accelerometer Preamplifier Type 2622. This preamplifier has graduated sensitivity controls, by means of which the sensitivity of the preamplifier is set in relation to the known sensitivity of the accelerometer so as to obtain exactly 10 mV/g for the 1025's input.

It is often of interest to obtain a graphical plot of the response of vibrated specimens. This is conveniently achieved by synchronizing the frequency scan of the 1025 with the frequency graduations on chart paper running through a Brüel & Kjær Level Recorder Type 2305.

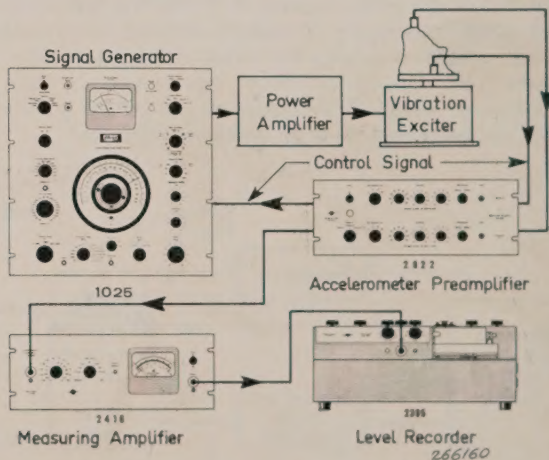


Fig. 1.2. Fundamentals of a vibration test set-up utilizing the Automatic Vibration Exciter Control Type 1025.

One Automatic Vibration Exciter Control can be set up as a "master" to control up to three similar "slave" units. In such an arrangement the "master" controls its own shaker table as well as the frequency of the output signal from the "slaves". Each "slave", however, can control the vibration level of its associated shaker. It is thus possible to synchronize the movement of up to 4 vibration exciters for the testing of large specimens. Furthermore, the phase relationship between the "master" and "slave" output signal can be adjusted over a full 360° angle.

With the Vibration Meter Type 2502 and auxiliary instruments Control Signal Selector Type 4410 and Vibration Programmer Type 4411 a variety of possibilities have been created for automatic programming of sweep-sine vibration testing. The entire instrumentation entails controls from up to four accelerometers simultaneously on an average, highest or lowest basis, and a break up of the test frequency range into six continuously adjustable frequency sub-ranges with individual function control in each range.

As test specimens become larger and more complex the vibration test engineer finds that the single accelerometer feedback control is inadequate. A multiple input test system in general has different mechanical impedances at the different input points, whereby differences in motion will occur. Fixture design aims at obliterating these differences but is seldom completely successful. Large differences in motion often occur from input point to input point, and a one-accelerometer control system results in overtesting or undertesting in important frequency ranges.

One way of reducing overtesting is to use as feedback signal an average of the vibration signals from the input points. If the averaging is done on an RMS basis this reduces the overtesting to a factor less than n , where n is the number of input points. Using for example four accelerometers at four input points will reduce overtesting to less than 12 dB. Undertesting will only be slightly affected.

If a further reduction of overtesting is found necessary this can be done by switching circuits automatically selecting the largest of the signals from the measuring points. Overtesting is thereby reduced to zero. Under testing is not remedied.

Undertesting due to different motion at input points can similarly be eliminated by selecting the smallest of the vibration signals for feedback. This procedure does not necessarily affect overtesting.

The instrumentation mentioned above has facilities for feedback control via the average, the highest or the lowest of up to four accelerometer signals using the average value of the signals as a basis for control.

As test specifications become more exacting with regard to excitation versus frequency characteristic, it is found desirable to have more possibilities of varying the slope of the characteristic over the frequency sweep. So far only one cross-over has been available, with cross over from constant displacement to constant acceleration etc., at a preselected frequency.

1. INTRODUCTION

The B & K equipment mentioned gives five adjustable cross-over points, with a variety of functions to choose from in each frequency sub-range, including an external filter facility. Thus any excitation versus frequency characteristic can be obtained for sweep-sine vibration tests. The Programming System mentioned here is described in Chapter 9.

The Automatic Vibration Exciter Control Type 1025 is available as B-model (cabinet version) and as C-model (for standard 19" rack mounting).

2. Description

The principle of operation is illustrated in the block diagram Fig. 2.1.

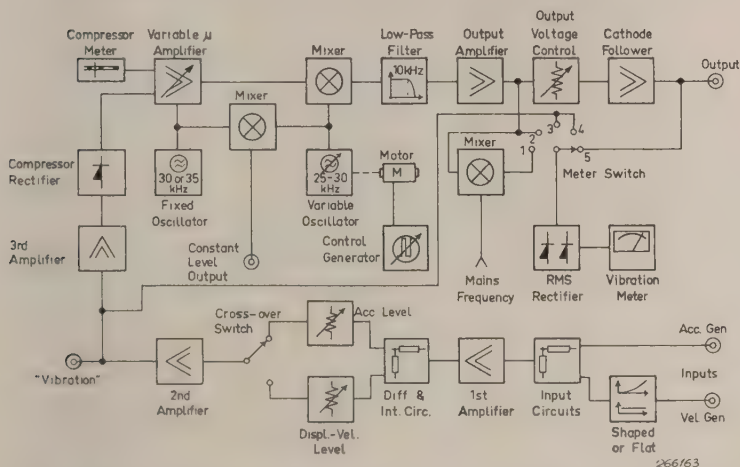


Fig. 2.1. Principle of the Automatic Vibration Exciter Control.

2.1. Oscillator.

The oscillator works on the heterodyne principle; by beating together two comparatively high frequencies – one from a variable and one from a fixed oscillator – an output frequency of between 5 and 10000 Hz is produced. The fixed oscillator oscillates at either 30 kHz or 35 kHz, depending on the setting of FREQUENCY RANGE. The variable oscillator frequency is between 25 kHz and 30 kHz, as determined by the position of the main tuning capacitor.

There are two main frequency ranges, 5-5000 Hz and 5005-10000 Hz. The first, which is covered in a true logarithmic sweep, is marked directly on the large circular scale. The second range is not logarithmic, the frequency being reckoned by adding 5000 Hz to the scale reading. Additionally there is a special frequency range of 0-5000 Hz which is made to allow the use of frequencies less than 5 Hz. The frequency is read on the inner scale.

2.2. Automatic Frequency Scan.

The frequency range can be continuously scanned with various speeds by a built-in synchronous motor which can be reversed electrically. The motor speed can be changed in six coarse steps, covering the range 0.3 to 100 degrees/min. Within each of the six steps the speed can be fine adjusted in 22 steps. Using both controls provided, there are 132 possible scanning speeds from 0.3 to 300 degrees min. Additionally there are six other scanning speeds suitable for achieving synchronism with the frequency-calibrated-paper transport on the Brüel & Kjær Level Recorder Type 2305.

The frequency range for to-and-fro scanning is easily adjusted. Unidirectional scanning throughout 360° is also possible, the output being cut dead while the pointer is on the blank part of the dial, and, if the scanning range is to be reduced, while on the unwanted sectors of the scale.

2.3. Vibration Derivation.

The input signal, which can come from either an accelerometer or a velocity pick-up, is processed according to the following table, depending on which quantity has been selected by FUNCTION SELECTOR.

Table I.
Frequency-weighting in the vibration derivation section.

Input	To read	Acceleration	Velocity	Displacement
Acceleration		Direct	- 6 dB/Oct.	- 12 dB/Oct.
Velocity		+ 6 dB/Oct.	Direct	- 6 dB/Oct.
Note: Differentiation; Equivalent to slope + 6 dB/Oct Integration; Equivalent to slope - 6 dB/Oct.				

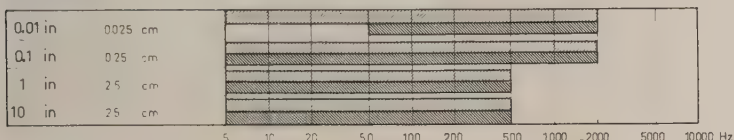
Considerable low-frequency noise is inherent in any measuring system involving integration, so special networks (which do not affect the measurements) are included to reduce this and to prevent the whole system from "hunting". ("Hunting" is a low frequency system oscillation which might otherwise occur when the generator frequency is a few thousand Hz).

In the two "Auto" positions of FUNCTION SELECTOR the relays governing which weighting function is effective at a given instant are switched at a predetermined generator frequency, adjustable between 8 and 1000 Hz.

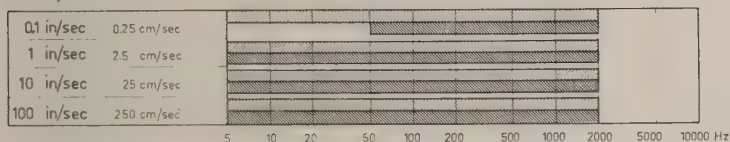
The acceptable ranges for measurement and control are given in Table II.

Table II.
Frequency Ranges for Measurement and Control.

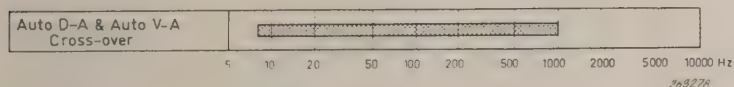
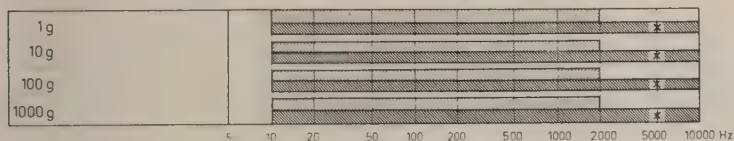
Displacement



Velocity



Acceleration



- Legend
- With Velocity Pick-up
 - With Accelerometer
 - Limits for Cross-over
 - * Exceeding 5 kHz requires the H.F. range

2.4. Compressor Arrangement.

Except when the COMPRESSOR SPEED switch is "Off",*) the vibration signal is fed to the regulation ("compressor") circuits. Here it is rectified and the resulting DC is used to bias a variable- μ stage in the generator. Thus, if the shaker table vibration becomes too great, a larger bias signal appears and the oscillator output drops until status quo is obtained. The integration time constant in the circuit which filters the rectified control signal is very important since it determines the speed with which a sudden change at the shaker table is regulated back to "normal". The various positions of COMPRESSOR SPEED offer a choice of fixed and programmed compressor speeds and these are discussed in the next chapter (under COMPRESSOR SPEED knob).

If desired the compressor speed can be made stepwise adjustable from external resistors or continuously adjustable from an external potentiometer. The external regulation of the compressor speed may be used in connection with the built-in possibilities of fixed and programmed compressor speeds.

In Fig. 2.2 is shown some distortion curves as a function of frequency for different compressor speeds. It can be seen that a compressor

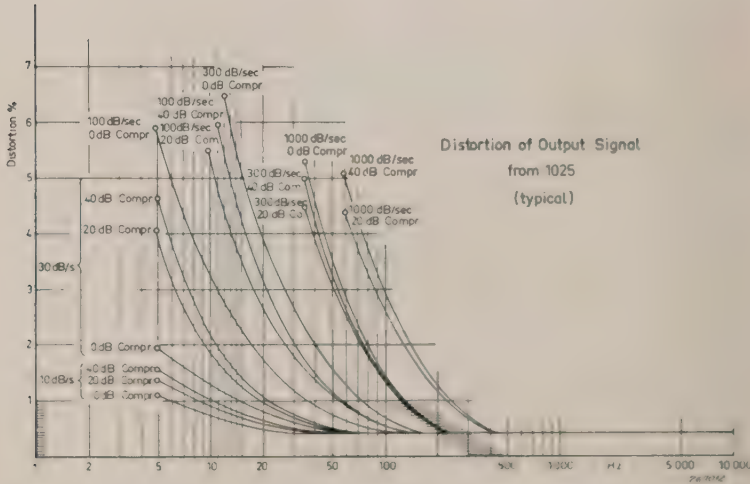


Fig. 2.2. Some distortion curves as a function of frequency for different compressor speeds.

*) The open-loop output voltage from the generator rises 10 dB as soon as COMPRESSOR SPEED is moved away from "Off".

speed as slow as possible should be chosen in order to avoid heavy distortion for low frequencies. It is also seen that least distortion occurs when the amount of compression is 0 dB. This should be kept in mind when the generator is set up to test. The amount of compression can be read on a built-in Compressor Meter during operation in the range 0-60 dB.

In the "Stand by" condition of METER SWITCH and, after suitable setting over unwanted sectors of the frequency scale, a cut-off bias is routed through the compressor to kill the generator output. For details on partial blocking of the frequency scale see section 5.4.

2.5. Warning System.

The warning lamp "Danger do not Switch" indicates with a red light that the compressor is operating and that the setting of the control knobs with red spots should not be altered. If the position of these knobs is altered when the lamp is alight violent changes in the vibration level can occur, which may damage the test specimen or the vibration system itself.

2.6. Meter Section.

The vibration meter enables easy setting and monitoring the vibration level. The moving coil meter which is fully protected against overload is calibrated to read peak acceleration in g, peak velocity in inches/sec (cm/sec) and peak-to-peak displacement in inches (cm). Instead of reading the vibration level it can be switched to read the RMS output voltage from the generator.

2.7. Constant Level Output.

By feeding the voltage from the fixed oscillator to a special mixer together with the signal from the variable oscillator, a constant output level of 1 V RMS following the frequency sweep of the generator is obtained. This voltage may for example be used to synchronize a stroboscope.

2.8. Frequency Calibration.

The generator is frequency calibrated by checking two points on the frequency scale against a well defined frequency. The reference frequency is that of the mains supply which is compared first to the fundamental and then to the fifth harmonic of the generator signal. This fifth harmonic is obtained by feeding part of the generator signal through a network causing heavy non-linear distortion. When the generator is correctly set to the fundamental of the mains supply frequency a zero beat appears on the indicating meter. Fine calibration

can be made in a similar way at one fifth of the mains frequency. Any necessary adjustment of the generator frequency is made by a separate control, changing the frequency of the variable oscillator.

2.9. Vibration Level Preset.

By feeding the Generator output voltage to the Vibration Meter as if it was a vibration signal the whole vibration test system can be set up for the required vibration level without feeding any signal to the power amplifier and shaker. A minimum of preset vibration is thereby applied to the test specimen.

2.10. Remote Control.

Various functions of the Automatic Vibration Exciter Control can be remotely controlled. The most important are:

1. Start and Stop of automatic frequency scan. This is particularly useful when frequency response curves of vibrated specimens are to be plotted on a B & K Level Recorder Type 2305.
2. Stand by, which is a condition of the generator where the output voltage is suppressed by the compressor.

These, and other remote control facilities, are fully covered in Chapter 7.

2.11. Parallel Operation of Generators.

When driving two or more complete vibration systems in parallel, the fixed and variable oscillators in one Automatic Vibration Exciter Control (the "master" unit) are used to feed the mixers in all the other ("slave") units. Associated with each mixer there is a PHASE control by means of which the outputs, though all of the same frequency, can be adjusted in phase relative to one another.

The various compressor systems are separate so that by adjusting the vibration LEVEL controls individually, the levels at each shaker need not be equal. However, since COMPRESSOR SPEED is normally set so that the regulation speed is programmed as a function of frequency, the switching on the "master" unit governs the regulation speeds of all units. Information concerning COMPRESSOR SPEED can be found in Chapter 3.

Full details about the setting up are given in Chapter 8

3. Control knobs, terminals etc.

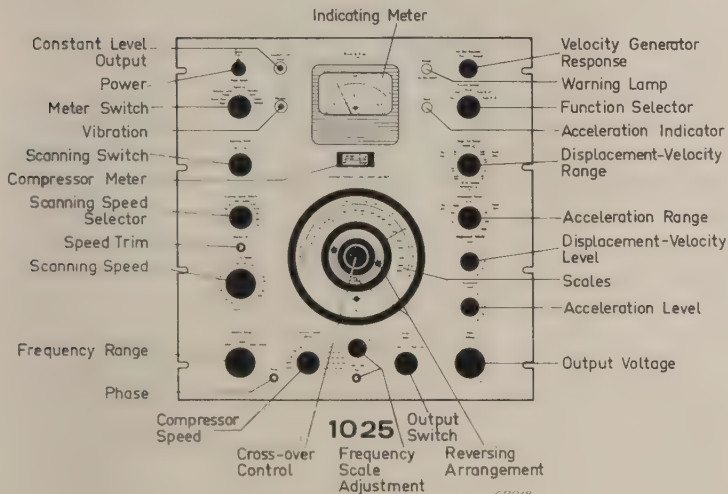


Fig. 3.1. Front panel.

Front Panel (Fig. 3.1)

POWER:

To switch the power on and off for the complete apparatus. When switched on the indicating meter and frequency scales are illuminated.

CONSTANT

LEVEL OUTPUT:

A voltage of 1 V RMS following the frequency of the generator is available.

The voltage may for example synchronize a stroboscope.

Load impedance should be greater than $10\text{ k}\Omega/3\text{ nF}$.

METER SWITCH:

"Power Frequency Beat". In this position the generator can be frequency calibrated against the mains supply frequency.

"Vibration Level Preset". By feeding the Generator output voltage to the meter section as if it was a vibration signal, the whole vibration test system can be set up for the required vibration level without feeding any signal to the power amplifier and shaker.

"Stand by". The generator output signal is suppressed by the compressor circuit more than 70 dB relative to full drive. The speed at which the signal is suppressed and rises again with COMPRESSOR SPEED set to "Off" is in the order of:

Decay time, 150 msec.

Rise time, 30 msec.

The rise time depends on the COMPRESSOR SPEED setting, i.e. a high speed gives a short rise time. The decay time, however, is independent of COMPRESSOR SPEED setting and has the value given above.

"Vibration Level". The output from the vibration derivation section is read directly on the meter.

"Output Voltage". RMS level of signal on socket OUTPUT (rear panel) is read. Full deflection indicates full RMS drive of the output stage.

VIBRATION:

Telephone jack for checking and monitoring the vibration level, e.g. by means of a Level Recorder (Chapter 6) or a cathode-ray oscilloscope.

SCANNING SWITCH:

"Scanning Off". The automatic frequency scanning drive is stopped instantaneously.

"Scanning On". The automatic frequency scanning drive is started instantaneously.

**SCANNING SPEED
SELECTOR:**

" $\times 0.3$ ", " $\times 1$ ", " $\times 3$ ", " $\times 10$ ", " $\times 30$ " and " $\times 100$ " are factors by which the degrees/min. value indicated on the SCANNING SPEED control should be multiplied. The product gives the actual scanning speed of the frequency pointer in degrees/min. The values given for the further six clockwise positions of the knob indicate the speeds available when the Br  l & Kj  r Level Recorder Type 2305 is used in conjunction with the Automatic Vibration Exciter Control (Chapter 6). When set to one of these six speeds the SCANNING SPEED control is automatically switched out of circuit.

SPEED TRIM: The motor speed can be fine adjusted by this screwdriver control. The exact frequency feeding the synchronous motor may be monitored at the socket SWEEP CONTROL B between pin 4 and chassis. The procedure, which is only necessary in connection with Level Recorder operation, is described in section 6.2.

SCANNING SPEED: For setting, in combination with SCANNING SPEED SELECTOR, the speed for the automatic frequency scan. To obtain the actual scanning speed in degrees/min., the value indicated by SCANNING SPEED has to be multiplied with the factor indicated by the SCANNING SPEED SELECTOR. The SCANNING SPEED control is not in operation when the SCANNING SPEED SELECTOR is set to one of the six values printed to the right of this control knob.

SCALES: **Outer Scale:** Linear in degrees angle for determining the scanning speed in degrees/min.

Middle Scale: Logarithmic for "5-5000 Hz" setting of FREQUENCY RANGE. Add 5000 Hz to pointer indication when using "5005-10000 Hz" range.

Inner Scale: 0-5000 Hz. Obtained by subtracting 5 Hz from the middle scale, not logarithmic.

FREQUENCY RANGE: **"5-5000 Hz".** The frequency scale is read directly on the middle scale. True logarithmic sweep.

"5005-10000 Hz". To find the output frequency, add 5000 Hz to the scale reading. Not a logarithmic sweep.

"0-5000 Hz". The frequency is read on the inner scale. Above 200 Hz the frequency scales nearly coincide so that the middle scale may also be used in this frequency range.

PHASE: In, for example, a "master-slave" arrangement, the phase between the individual generator outputs can be adjusted. The phase shifting range covered by this control is approximately 150°.

COMPRESSOR SPEED: For setting the regulation speed of the compressor arrangement.

"10", "30", "100" "3000" indicate fixed regulation speeds in dB/sec. which do not change as a function of frequency.

"10-30-30-30-30", "10-30-100-100-100" ... "10-10-10-30-100" refer to different programmed changes in regulation speed as a function of frequency. The compressor speed is altered step-wise to the various values at the change-over frequencies given in the table below:

Table III.

Change-over frequencies	30	100	300	1000	Hz
Compressor speed positions	10	30	30	30	30 dB/sec
	10	- 30	- 100	- 100	100 »
	10	- 30	- 100	- 300	300 »
	10	30	- 100	- 300	1000 »
	10	10	- 30	- 100	300 »
	10	- 10	- 10	- 30	100 »

Continuously adjustable compressor speed can be introduced by replacing the short-circuiting link between pins 2 and 3 of the COMPRESSOR socket by a potentiometer. It may be used in connection with the built-in possibilities described above.

COMPRESSOR METER: The amount of compression can be read during operation in the range 0-60 dB.

Cross-Over Control: Of interest when using "Auto D-A" or "Auto V-A" positions of FUNCTION SELECTOR. Turning the small knob relative to the large one alters the cross-over frequency. (Limits 8 Hz to 1000 Hz).

FREQUENCY SCALE ADJUSTMENT:

For frequency calibration of the generator: changes the frequency of the variable oscillator. The screw-driver operated control is for coarse adjustment in case the range of the fine adjustment knob is not sufficient.

Reversing Arrangement: The arm, when hit by the sweep stops, causes the sweep motor to change direction. Must be in place

for to-and-fro scanning but must be removed for continuous uni-directional scanning.

The two knurled set screws are positioned in their slot so as to flick the reversing arm at the chosen limits of scan.

OUTPUT SWITCH:

"Linear". The amplitude-frequency characteristic of the generator is flat, i.e. independent of frequency.

"High Pass". The lower part of the frequency range is attenuated by a high-pass filter. The limiting frequency is 30 Hz and the maximum slope is 6 dB/octave below this frequency. Useful for constant displacement operation at low frequencies.

OUTPUT VOLTAGE:

Continuously variable logarithmic potentiometer located at the input of the output cathode follower. When OUTPUT VOLTAGE is turned fully counter-clockwise the reset circuit terminals are short-circuited and the Warning Lamp switches off if it is alight.

**ACCELERATION
LEVEL:**

Potentiometer to control the acceleration level of the shaker in conjunction with FUNCTION SELECTOR and ACCELERATION RANGE. The level can be read off the instrument meter when the METER SWITCH is in position "Vibration Level".

**DISPLACEMENT-
VELOCITY LEVEL:**

Potentiometer which controls the displacement level or the velocity level of the vibration exciter, the type of control being dependent upon the positions of FUNCTION SELECTOR and DISPLACEMENT-VELOCITY RANGE. With METER SWITCH in position "Vibration Level" the actual vibration level can be read off the instrument meter.

**ACCELERATION
RANGE:**

For choosing a suitable acceleration range (values in peak g) allowing easy reading of the meter. Use the left-hand positions if the control transducer is a velocity pick-up, and the right-hand positions if it is an accelerometer.

**DISPLACEMENT-
VELOCITY RANGE:**

Whether it is displacement or velocity that is in question depends on the setting of FUNCTION SELECTOR.

Large figures: inches peak-to-peak displacement.
Small figures: centimetres peak-to-peak displacement.

For velocity readings, the full-scale values are 10 times the numbers shown and are single peak.

When a velocity pick-up is used as transducer, set to one of the left-hand positions. With an accelerometer, set to one of the right-hand positions.

FUNCTION SELECTOR: For setting the required type of measurement or regulation. When the compressor is switched in and FUNCTION SELECTOR is on "Vel." the velocity level of the shaker table is controlled. Similarly, if on "Displ." or "Acc." the displacement or acceleration levels respectively are held constant.

"Auto D-A": Constant displacement is maintained below the cross-over frequency, and constant acceleration above it.

"Auto V-A". Constant velocity is maintained below the cross-over frequency, and constant acceleration above it.

Either an accelerometer or a velocity pick-up may be used for any function, and in the case of the two "Auto" conditions, one kind of transducer may be employed below cross-over and the other kind above cross-over.

VELOCITY GENERATOR RESPONSE: **"Shaped".** To compensate the frequency characteristic of MB velocity pick-ups Model 124 or 126.

"Flat". The response is flat from 5 Hz to 2000 Hz.

Acceleration Indicator: A lamp which lights whenever the derived vibration signal is acceleration. This is useful when setting the cross-over frequency in "auto" operation.

Danger do not Switch: The warning lamp indicates with a red light that the compressor is operating and that the setting of the control knobs with red spots *should not be altered*. The knobs with red spots are FREQUENCY RANGE, COMPRESSOR SPEED, FUNCTION SELECTOR, DISPLACEMENT-VELOCITY RANGE, ACCELERATION RANGE and OUTPUT SWITCH.

If the position of these knobs is altered when the lamp is alight violent changes in the vibration level can occur, which may damage the test specimen or the vibration system itself.

Identical warning lamps may be built-in in other instruments in the complete vibration system. By making appropriate connections from the Automatic Vibration Exciter Control to these instruments, their warning lamps will be controlled from the warning lamp control circuit in the Vibration Exciter (see Relay Control A page 24).

INDICATING METER: Measures the peak value of the acceleration or velocity level and the peak-to-peak value of the displacement. The meter can also measure the RMS value of the output voltage. Inches, inches/sec, g and volt is read on the scale 0-10 while cm and cm/sec is read on the scale 0-25. The moving coil system is fully protected against electrical overload.

Back Plate (Fig. 3.2).

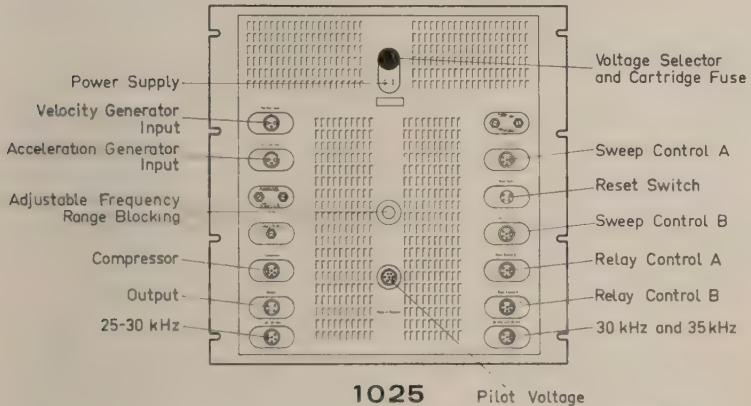


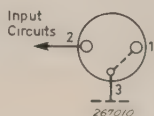
Fig. 3.2. Back plate.

Note: Various pre-set controls are visible but these are not mentioned below and *must not be touched* without recourse to the Service Manual for Type 1025 and to proper test equipment.

The wiring shown in the accompanying diagrams is internal. All sockets are viewed externally. The necessary external connections are described in the text.

Where a shorting link is shown (dashed line) this is soldered onto the inside of the socket. Such links may have to be removed when wiring up one of the special facilities. For standard procedures, however, they must be in place.

VELOCITY GENERATOR INPUT:



Plug: Cannon WK-C3-21C.

Pins 1 (3) and 2:

Input for direct connection to a velocity sensitive (electrodynamic) transducer which should have a sensitivity of 96.3 mV per inch/sec.

Input impedance: 200 k Ω approx.

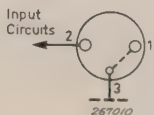
Transducer impedance: 2000 Ω max.

ACCELERATION GENERATOR INPUT: Plug: Cannon WK-C3-21C.

Pins 1 (3) and 2:

Input for connection to an accelerometer via an Accelerometer Preamplifier Type 2622. The latter ensures correct signal scaling (10 mV/g) regardless of the accelerometer sensitivity.

Input impedance approximately 80 k Ω .



COMPRESSOR:

Plug: Cannon WK-6-21C.

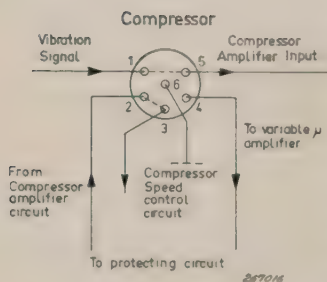
Pins 1 and 5:

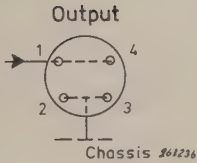
If it is desired to give the compressor circuit a particular frequency weighting, a network with the required shaping characteristic can be inserted between 1 and 5. The standard inter-connection between the two pins has to be removed.

Pins 2 and 4:

Intended for connection of a system protecting circuit, which switches off the shaker power amplifier if sudden changes in the feed back voltage occur.

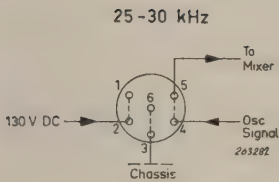
The short-circuiting link between pins 1 and 5 should be removed for connection with the CONTROL SIGNAL OUTPUT socket of 4411, and the one between pins 2 and 3 should be removed for connection with the COMPRESSOR VOLTAGE socket of 4410. External continuous regulation of the compressor speed can be introduced between pins 2 and 3 when the short-circuiting link is removed.



OUTPUT:

Plug: Cannon WK-4-21C.

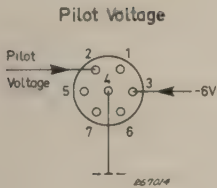
Generator output terminal. Indicating meter measures at this terminal when METER SWITCH is in position "Output Voltage".

25-30 kHz:

Plug: Cannon WK-6-21C.

Variable oscillator output.

Pin 5: To be utilized in a "master-slave" arrangement; see section 8.2.

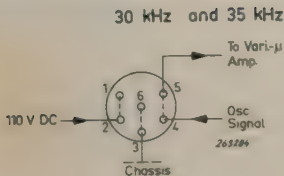
PILOT VOLTAGE:

Plug: Cannon WK-A7-21C.

Pin 2. Pilot voltage for the Vibration Programmer Type 4411 governed by the angular position of the frequency scale pointer.

Pin 3. -6 V DC.

Pin 4. Ground.

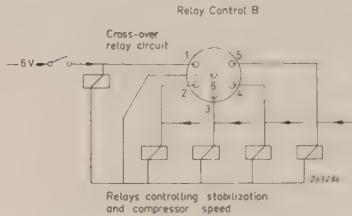
30 kHz AND 35 kHz:

Plug: Cannon WK-6-21C.

Fixed oscillator output.

Pin 5: For connection to associated "slaves" where applicable.

RELAY CONTROL B:

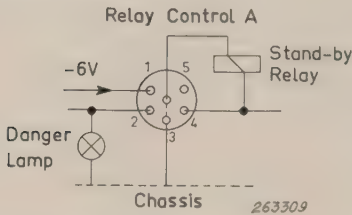


Plug: Cannon WK-6-21C.

Pin 1: For governing the cross-over relay circuit in associated "slaves". 6 V is present on pin 1 when the cross-over switch is closed.

Pins 2, 3, 4 and 5: For governing the compressor relays and stabilizing relays in associated "slaves".

RELAY CONTROL A:

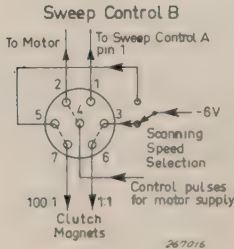


Plug: Cannon WK-6-21C.

Pin 4: For energizing the stand-by relay in associated "slaves".

Pin 2: For operation of "Danger do not Switch" lamps remotely controlled by the generator. -6 V is present when the compressor is operating.

SWEEP CONTROL B:



Plug: Cannon WK-A7-21C.

Pins 2 and 4: Intended for remote control of motor start and stop. Further instruction is given in sections 6.2 and 7.1. Between 4 and chassis, the control signal for the motor can be monitored.

Pins 3 and 6, 5 and 7: For remote control of a gear shift arrangement in the scanning system. (Section 7.4).

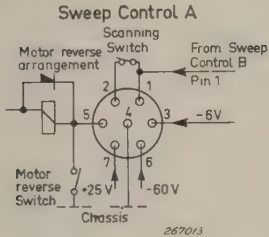
Pin 1: When using Motor Drive UM 1018 pins 1 and 2 are short-circuited by a plug whereby the motor drive signals are fed to UM 1018.

RESET SWITCH:



Plug: Cannon WK-4-21C.

Relay contact connection for resetting the shaker power amplifier when this has been disconnected by a system protecting circuit. The relay is governed by the OUTPUT VOLTAGE control and the contact pair will close when OUTPUT VOLTAGE control is turned fully counter-clockwise.

SWEEP CONTROL A:

Plug: Cannon WK-A7-21C.

Pins 1 and 2: For remote operation of the paper drive start and stop of a Brüel & Kjær Level Recorder Type 2305 (see section 6.2).

When SCANNING SWITCH is set to position "On" the contact between pins 1 and 2 opens.

Pins 4 and 5: For remotely reversing the scanning motor.

NOTE: The arm of the motor reverse switch should be unscrewed during remote control.

Pins 1, 3, 4, 5, 6 and 7: For remote operation of the Motor Drive UM 1018. (See section 6.2-2).

Cartridge Fuse and

Mains Voltage Selector: Concerning the fuse see below. The instrument can be set to operate from 100, 115, 127, 150, 220 or 240 Volts mains supply, 50-400 Hz.

Fuses:

Main Fuse: 1.6 A medium lag. The fuse holder is combined with the MAINS VOLTAGE SELECTOR at the rear of the apparatus. Two spare fuses are placed in a holder on the upper chassis, accessible after removing the rear plate.

6 Volts DC Supply. 2.5 A normal. Protects the 6 V DC supply circuit. The fuse is of the "soldered in" variety. It is accessible from the rear of the apparatus after the rear plate has been removed, and is located on the vertical plate to the right of the capacitor unit.

On removing the rear plate, the following additional facilities may be catered for:

Adjustable Frequency**Range Blocking:**

Three cam discs are mounted on the frequency scale pointer shaft. These operate a pair of contacts which in turn control the Stand-by circuit of the generator. One cam disc, which is permanently fixed on the shaft, sets the generator to stand-by when the frequency scale pointer is outside the frequency scale graduation. The two other discs are

adjustable inside the frequency scale graduation, so that any initial or final part of the frequency range can be blocked, i.e. the generator will be on stand-by outside the preset ranges. Detailed instruction is given in section 5.4.

4. Operation as Vibration Meter

To take the procedure in easy stages, the simple case where the instrument is used to measure vibrations on a self-excited structure such as an engine will be considered in this chapter. The technique is not only applicable to this kind of investigation but is also an essential part of the laboratory test systems discussed in later chapters. Proper measurement is fundamental to any vibration study.

In addition to the Automatic Vibration Exciter Control, either an accelerometer and Accelerometer Preamplifier Type 2622 or alternatively a velocity pick-up will be required.

4.1. Setting to Main Voltage.

Before connecting the 1025 (or the Preamplifier) to the mains, ensure that the voltage selector, located at the rear, is adjusted to the correct supply voltage. To readjust:

1. Remove fuse by turning centre piece of voltage selector one quarter anti-clockwise.
2. Turn the centre ring of the selector with a coin so that the white mark points to the desired voltage.
3. Replace fuse.

4.2. With a Velocity Pick-up.

Connect the pick-up to VEL. GEN. INPUT. The pick-up should preferably have a sensitivity of 96.3 peak mV per peak inch/sec. M.B. Models 124 or 126 are satisfactory.

Set

POWER	to "On"
METER SWITCH	"Vibration Level"
SCANNING SWITCH	"Off"
VEL GEN. RESPONSE	"Shaped", if an M.B. velocity pick-up Model 124 or 126 is used. Otherwise to "Flat"
ACCELERATION LEVEL	Fully clockwise, "10"
DISPL. - VEL. LEVEL	Fully clockwise, "10"

Now decide what is to be measured, viz. Displacement, Velocity, or Acceleration, and set FUNCTION SELECTOR accordingly.

If acceleration is to be measured, set ACCELERATION RANGE to a suitable value, choosing one of the four left hand side positions. The reading is in peak g and the scale may be read directly provided the pick-up has a sensitivity of exactly 96.3 mV per inch/sec. If displacement or velocity are of interest, set DISP. - VEL. RANGE to one of the four left hand side positions. The meter then reads, for 96.3 mV per inch sec. pick-up sensitivity, peak velocity or peak-to-peak displacement. Note that the full scale *velocity* reading is ten times the figure quoted around the DISPL. - VEL. RANGE control. The acceptable frequencies for measurement in the various ranges are given in Table II, p. 11.

4.3. With an Accelerometer.

The mounting of the accelerometer and its connection to the Accelerometer Preamplifier Type 2622 is explained in the manual for Type 2622. Take the OUTPUT of the 2622 to the ACC. GEN. INPUT of the Automatic Vibration Exciter Control.

I. Set up the Accelerometer Preamplifier:

POWER to "On"

Set the SENSITIVITY knobs to the sensitivity of the accelerometer to be used and set the LOW FREQUENCY LIMIT control to the highest acceptable value (refer Table II, p. 11).

Note: If a preamplifier other than Type 2622 is used, it must incorporate sharp cut-off filters to attenuate frequencies outside the range of the 1025, and also its power supplies must be scrupulously stabilized. There should be provision for rationalizing its output scaling to 10 mV/g.

II. Referring to the 1025, set

POWER to "On"
METER SWITCH "Vibration Level"
SCANNING SWITCH "Off"
ACCELERATION LEVEL Fully clockwise, "10"
DISPL. - VEL. LEVEL Fully clockwise, "10"

Now decide what is to be measured, viz. Displacement, Velocity, or Acceleration, and set FUNCTION SELECTOR accordingly.

If acceleration is to be measured, set ACCELERATION RANGE to a suitable value, choosing one of the four right hand side positions. Read the meter scale directly in peak g. If displacement or velocity are of interest, set DISP. - VEL. RANGE to one of the four right hand side positions. The meter then reads peak velocity or peak-to-peak displacement. Note that the full scale *velocity* reading is ten times the figure quoted around the DISPL. - VEL. RANGE control. The acceptable frequencies for measurement in the various ranges are given in Table II, p. 11.

5. Operation as Shaker Control

The operation of part of the equipment, i.e. the part which actually measures the vibrations, has already been discussed in Chapter 4. The present chapter starts with explanations about how to operate the generator itself (also the compressor), and finishes with schemes which summarize all the manipulations.

5.1. Calibration of Frequency Scale.

Check the mains voltage selector (section 4.1.) and switch POWER "On". Allow a few minutes to warm up.

Set

METER SWITCH	to "Power Freq. Beat"
SCANNING SWITCH	"Of"
FREQUENCY RANGE	"5-5000 Hz"
COMPRESSOR SPEED	"Off"
OUTPUT SWITCH	"Linear"

Frequency scale pointer to frequency of the mains.

Turn FREQUENCY SCALE ADJUSTMENT until a beat shows up on the indicating meter. Fine adjust by same knob until beat ceases. In case the range covered by the control is insufficient, use also the coarse adjustment control (screwdriver operated).

NOTE: The meter pointer swing for a slow fluctuation may be in the order of 8 dB peak to peak.

Thereafter set frequency scale pointer to $1/5$ of mains frequency. Fine adjust again by FREQUENCY SCALE ADJUSTMENT control to obtain zero beat.

NOTE: The meter pointer swing for a slow fluctuation will now be in the order of 1 dB peak to peak.

NOTE: It is not necessary to disconnect the generator output from the power amplifier, as there is no output when the METER SWITCH is set to "Power Frequency Beat".

The compressor circuit may be in operation during the calibration but if it is, a beat can be obtained only if a deflection of around 0 dB is read on the Compressor Meter. This may be obtained by adjusting the vibration LEVEL potentiometer corresponding to the position of the FUNCTION SELECTOR but if impossible the COMPRESSOR SPEED should be switched to "Off".

5.2. Adjustment of Automatic Frequency Scanning Range.

- a. Choose the correct setting of FREQUENCY RANGE. For the 5005-10000 Hz range, 5000 Hz must be added to the scale reading. Note that the scale is logarithmic only for the 5-5000 Hz range

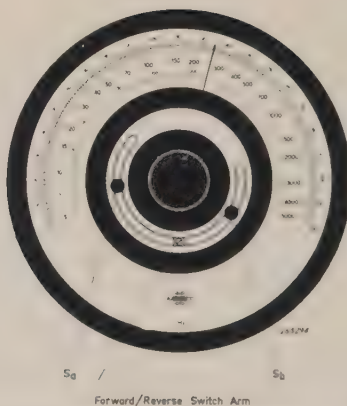


Fig. 5.1. Frequency Dial, also showing the adjustable stops for the automatic reversing mechanism.

- b. Loosen the finger screw Sa and Sb on the slotted plate, Fig. 5.1.
- c. Turn Frequency scale to the lower frequency limit of the range within which it is desired to scan.
- d. Set reverse-switch arm, located underneath guide slot, to its left hand position.
- e. Move screw Sa counter-clockwise in the circular guide slot so far that the reverse switch just switches. Fasten screw Sa in this position.
- f. Turn frequency scale pointer clockwise to the point of the higher frequency limit of scanning range.
- g. Move screw Sb clockwise so far that the reverse switch just switches. Fasten screw Sb in this position.

The selected frequency range will now be scanned automatically in a forward and reverse direction if SCANNING SWITCH is set to "On"

5.3. Uni-directional Frequency Scanning.

Normally the automatic frequency scanning is performed as a series of forward reverse scans and the scanning range is adjusted as described in section 5.2 above. However, in some cases it may be advantageous to scan the frequency range a number of times in one direction only. This is possible if the reverse-switch arm is removed. The arm can be easily unscrewed from the associated micro-switch by means of a screwdriver, see Fig 5.1. If the arm is pushed to the right before it is unscrewed a continuous "forward" scanning of the frequency range is obtained, while pushing the arm to the left results in continuous "reverse" scanning. When used for continuous uni-directional scanning it

is often necessary to partially block the upper and/or lower part of the frequency scale range. The manipulations necessary to carry out the blocking are described below.

5.4. Partial Blocking of Frequency Scale Range.

The initial and/or the final part of the frequency scale can be blocked out by two adjustable cam discs. This facility can be utilized when the frequency scale pointer has to perform uni-directional scanning. Any initial part, 10 Hz up to 400 Hz of the scale, can be blocked, and/or any final part, 5000 Hz down to 300 Hz.

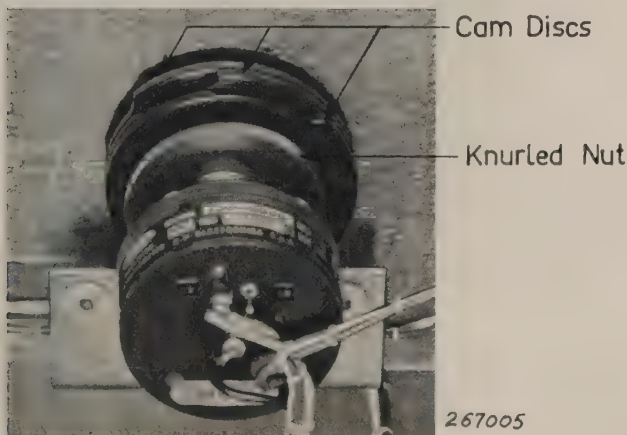


Fig. 5.2. Removing the back plate reveals some cams mounted at the rear of the tuning condenser. These cams are responsible for cutting the generator output while the pointer is in certain sectors of the frequency dial.

The blocking range is adjusted as follows:

- a. Remove rear plate of apparatus.
- b. Loosen knurled lock-nut (Fig. 5.2) sufficiently for the outer and inner cam discs to be moved in relation to the one in the middle.

NOTE: If it is not possible to hold the frequency pointer shaft in a fixed position by holding the frequency adjustment knob (front plate), the automatic scanning can be switched on and set to lowest speed.

- c. Set, for example, outer cam disc for initial blocking so that the generator "Stand By" is released at the desired frequency. The point of release can be observed on the COMPRESSOR METER

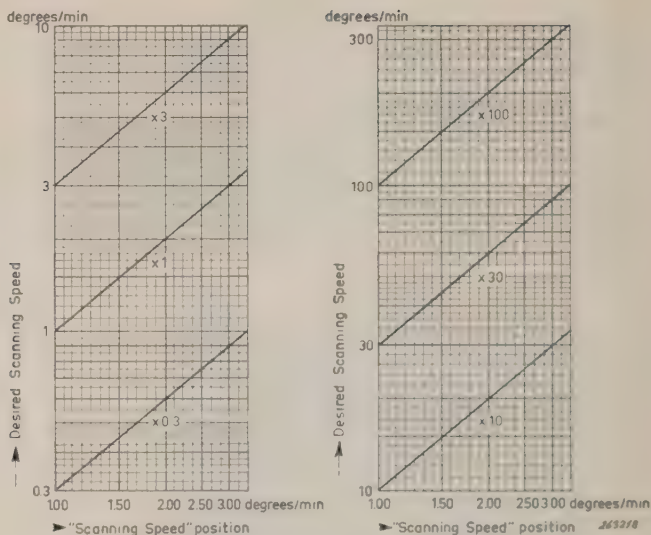


Fig. 5.3. Scanning speeds in degrees/minute given by the various combinations of SCANNING SPEED and SCANNING SPEED SELECTOR.

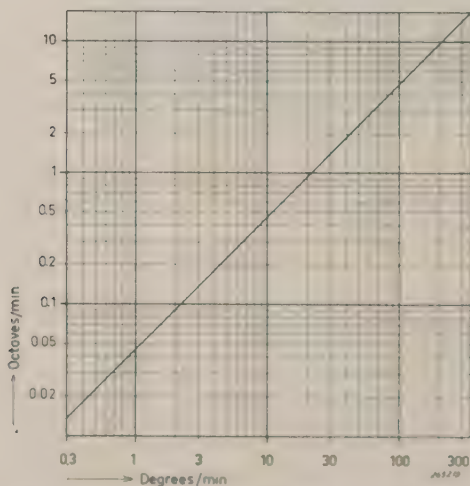


Fig. 5.4. Scanning speeds in degrees/minute converted into octaves/minute. Valid only for the 5-5000 Hz frequency range.

when METER SWITCH is set to "Power Frequency Beat" and COMPRESSOR SPEED to "Off". When released the meter pointer will suddenly deflect.

- d. Set the inner cam disc for final blocking so that the generator is switched to "Stand By" at the desired frequency, observed by a sudden meter pointer deflection to 60 dB.
- e. Tighten the knurled lock-nut.
- f. Replace rear plate.

5.5. Setting of Scanning Speed.

If a certain frequency range f_1 to f_2 has to be scanned in t minutes use the following procedure:

- a. Determine from the frequency scale the number of degrees d the range f_1 to f_2 covers.
- b. Find scanning speed S in degrees/min. from:

$$S = \frac{2 \times d}{t} \text{ degrees/min.}$$

- c. From the curves in Fig. 5.3 can be found the position of SCANNING SPEED SELECTOR and SCANNING SPEED which give a speed nearest the calculated value S . Fig. 5.4 gives the relationship between Octaves/min. and Degrees/min. for cases when the scanning speed is specified in octaves/min.

5.6. Setting Regulation Speed.

The choice of COMPRESSOR SPEED depends largely on two factors:

- a. The lowest frequency used. A very fast control system will, at low frequencies, be able to interact with the signal waveshape and thus introduces harmonic distortion. Consequently, if distortion must be minimized, COMPRESSOR SPEED should not be set to higher values than stated in Table IV.

Table IV.

Lowest Frequency of chosen sweep range Hz	COMPRESSOR SPEED dB/sec.
5	10
30	30
100	100
300	300
1000	1000
3000	3000

- b. The rate with which resonances build up during scan. Obviously the system must be able to adjust itself faster than the mechanical frequency-response is changing.

When the scanning speed is low enough it is possible to satisfy both the conflicting requirements a. and b. by using one of the six fixed compressor speeds. However, it is often convenient in practice to use one of the six "auto" programmes so that the compressor speed changes with frequency, thus maintaining an optimum speed throughout the range of interest. The choice of program depends upon the required distortion limits and upon instabilities in the regulation loop.

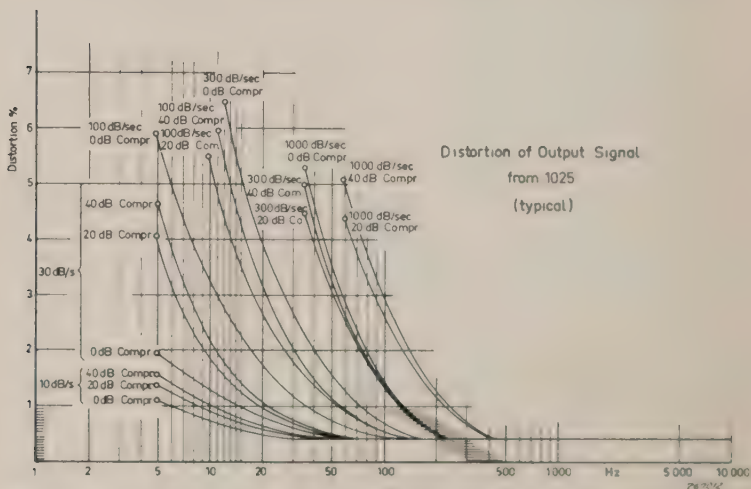


Fig. 5.5. Some distortion curves as a function of frequency for different compressor speeds.

The distortion dependent upon compressor speed can be seen in Fig 5.5. The curves show that a compressor speed as low as possible should be chosen at low frequencies. The curves also show that least distortion occurs when the amount of compression is 0 dB. It is therefore essential that the minimum compression during the sweep through the frequency range is adjusted to 0 dB (see section 5.9).

Too fast compressor speed may cause instability in the regulation loop (instability shows up on a monitoring oscilloscope as amplitude modulations of the sine-wave test signal). Should instability occur during the sweep the setting of the COMPRESSOR SPEED knob should be changed to a program containing lower compressor speeds. If it is impossible

to obtain good control with one of the programmed compressor speeds it is necessary to utilize a fixed compressor speed condition, see item 5.6a.

Warning: Do not alter the position of the COMPRESSOR SPEED knob unless the OUTPUT VOLTAGE control is turned fully anticlockwise, switching off the warning lamp.

5.7. Possibilities.

Either a velocity pick-up or an accelerometer may be used as the transducer sensing the motion of the shaker table. The Automatic Vibration Exciter control is capable of controlling the displacement, or the velocity, or the acceleration of the shaker table within the frequency limits indicated by Table II, p. 11.

It is possible to control displacement at low frequencies and acceleration at higher frequencies, the frequency of cross-over from displacement control to acceleration control being easily adjustable (section 5.8). This kind of test will be known as "Auto D-A".

Similarly, velocity may be controlled at low frequencies, crossing over to acceleration at higher frequencies,—the "Auto V-A" facility.

The upper and lower frequency limits for the two "auto" cases are governed by the performance on displacement, velocity, or acceleration as the case may be. The cross-over is adjustable between 8 Hz and 1000 Hz.

Constant acceleration tests from low frequencies up to 10000 Hz must be made in two stages; FREQUENCY RANGE being switched manually before the second test.

5.8. Setting Auto Cross-Over Frequency.

Set SCANNING SWITCH to "Off".

Set FUNCTION SELECTOR to "Auto D-A" or "Auto V-A".

Position the frequency pointer on the desired cross-over frequency. (Anywhere between 8 Hz and 1000 Hz is possible in principle). Hold the large tuning knob stationary and turn the small knob relative to it until the ACCEL. indicator lamp flickers, thus showing the position where operation is just passing to or from acceleration.

Sweep the pointer manually through cross-over and check that the transition point is correct. Fine adjust if necessary.

5.9. Vibration Level Preset.

Set the METER SWITCH to "Vibration Level Preset", COMPRESSOR to the desired position (not "Off") and OUTPUT VOLTAGE fully anticlockwise so that the warning lamp is not alight.

Set the frequency pointer somewhere in the range which is going to be used. Set the cross-over frequency to the required position.

Set FUNCTION SELECTOR and the range switches to suitable positions, for example to preset a vibration level of 0.5 g acceleration, the FUNCTION SELECTOR is set to "Accel." and the ACCELERATION RANGE switch is set to 1 g.

Adjust the VIBRATION LEVEL potentiometers to obtain the desired indication below and above the cross-over. There should normally not be a jump in vibration level at cross-over. See nomograph in Chapter 10.

Set METER SWITCH to "Stand by", and all other switches to suitable positions, whereby testing may be started. During the first sweep adjust the Generator OUTPUT VOLTAGE so that minimum compression during sweep is in the vicinity of 0 dB but not less.

5.10. Summary of Preparatory Operations.

- I. Calibrate the frequency scale (section 5.1).
- II. Set up the scanning range* and speed required by the particular test specification. (Section 5.2 to 5.5). Having done this, leave SCANNING SWITCH on "Off".
- III. If auto cross-over is to be employed, adjust the cross-over frequency to that required by the particular test specification (section 5.8 describes the method).
- IV. Adjust the vibration level by using the "Vibration Level Preset" facility (section 5.9).

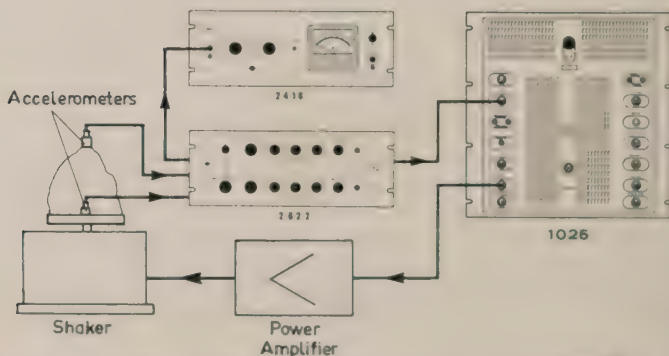


Fig. 5.6. Laboratory vibration-test system using an accelerometer as control transducer. Note the possibility of attaching a second accelerometer for monitoring the behaviour of the specimen.

* Do not forget to position FREQUENCY RANGE correctly. Also check on Table II, p. 11 that the chosen range is admissible.

- V. Connect the shaker table transducer to the 1025. When automatic cross-over is employed, both a velocity pick-up and an accelerometer may be used.

See sections 4.2 and 4.3 for full details; however, briefly the procedure is:

<i>With accelerometer</i>	<i>With vel. pick-up</i>
Signal to ACC. GEN.	Signal to VEL. GEN. INPUT
INPUT via preamplifier	VEL. GEN. RESPONSE to
	"Shaped" for MB/124 or 126

- VI. Connect pins 1 and 2 of OUTPUT to a power amplifier and thence to the shaker; see the manuals for these two pieces of equipment. This completes the arrangement shown in either Fig. 5.6 or Fig. 5.7.

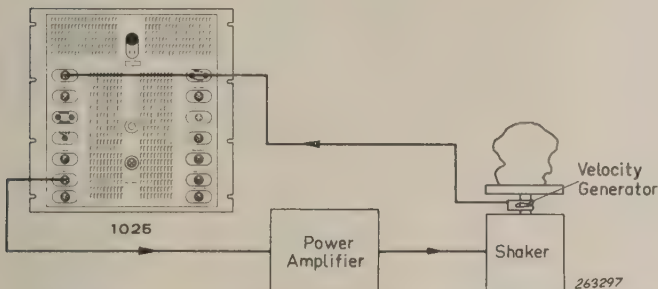


Fig. 5.7. Laboratory vibration test system using a velocity pick-up as transducer. Sometimes the velocity pick-up is a signal generator coil actually built into the shaker table.

5.11. Operation Schemes.

When the preparations outlined in section 5.10 have been completed, decide which of the five kinds of control enumerated along the top of Table V is wanted. Enter the table at the top of the appropriate column and work progressively downwards.

If in doubt about the meaning of the knob markings, refer to Chapter 3. To be sure that the levels are set up correctly, the working of the vibration derivation section must be properly understood; see Chapter 4.

TO STOP a test at any point, turn

SCANNING SWITCH to "Off"

and

METER SWITCH to "Stand by"

simultaneously.

Table V.

Operation Schemes for the possible constant vibration level tests.
N.B. Look through section 5.10 before proceeding further.

In order to maintain on the shaker table		Constant Acceleration	Constant Velocity	Constant Displacement	Constant Displacement below x-over Constant Acceleration above x-over	Constant Velocity below x-over Constant Acceleration above x-over
Object of each step	Set					
Choose vibration derivation	a) FUNCTION SELECTOR	"Acc."	"Vel."	"Displ."	"Auto D-A"	"Auto V-A"
Choose range given by spec.1)	b) DISP. - VEL. RANGE ²⁾	-	As required	As required	As required below x-over	
	c) ACCEL. RANGE ²⁾	As required	-	-	As required above x-over ²⁾	
Assist in equalizing L. F. response	d) OUTPUT SWITCH	"Lin."	"High Pass"		"High Pass"	
Set regulation speed	e) COMPRESSOR SPEED	As required - see section 5.6				
"Open up" the generator, checking that vibrations are held down by control loop	f) METER SWITCH	"Vibration Level"				
	g) OUTPUT VOLTAGE	Turn slowly clockwise (at low compressor speed very slowly) and check on meter scale that vibrations do not exceed desired level. The Compressor Meter will under this process show an increasing deflection. Note: Correct functioning of regulation loop is indicated by meter deflection not rising above a certain small level even though OUTPUT VOLTAGE is further increased				

Adjust gain so that gen. operates over optimum regulation characteristic	h) METER SWITCH	"Vibration Level"
	j) OUTPUT VOLTAGE	Adjust so that as frequency pointer is swept manually through, minimum compression is in the vicinity of 0 dB but not less ¹⁾
Check levels	k) METER SWITCH	"Vibration Level"
	l) SCANNING SWITCH	"On". Observe one sweep. Trim LEVEL control(s) if necessary
Check drive	m) METER SWITCH	"Vibration Level" (or "Output Voltage"). Re-check that the pointer of the compression is in the vicinity of 0 dB but not less ²⁾ Trim OUTPUT VOLTAGE if necessary
Test running	n) METER SWITCH	"Vibration Level" (or "Output Voltage"). The test is now set up

TO STOP a test, turn SCANNING SWITCH to "OFF" and METER SWITCH to "Stand-By".

NOTES:

- 1) Refer to the test specification which is to be followed by the operator.
- 2) Use left-hand positions when the signal originates from a velocity pick-up; right-hand positions for an accelerometer.
- 3) There should normally not be a jump in level on cross-over. Acceleration just above cross-over then corresponds to vibration level existing just below, in other words the excitation level will be the same on both sides of cross-over. See nomograph in Chapter 10.
- 4) Choose suitable Power Amplifier gain; this is complementary to OUTPUT VOLTAGE setting.

Re-start the same test by returning
METER SWITCH to "Vibration Level" (or "Output Voltage") and
SCANNING SWITCH to "On".

This is particularly useful when changing specimens on the shaker table
To change from one kind of test to another, turn
SCANNING SWITCH to "Off".

OUTPUT VOLTAGE fully anticlockwise (the warning lamp switches off).
METER SWITCH to "Vibration Level Preset".

Then make new preparations (section 5.10 II. to V.) and follow the
column in Table V relating to the next test.

WARNING

When the red lamp DANGER DO NOT SWITCH is alight, the
knobs with red spots must not be touched by untrained personnel,
otherwise permanent damage may be caused to the specimen
and shaker table.

6. Operation with Level Recorder

6.1. Possibilities.

The frequency scan of the Automatic Vibration Exciter Control Type 1025 can be synchronized with the paper drive of the B & K Level Recorder, Type 2305. The synchronization may be made in two ways:

- 1) by using the six scanning speeds made especially for operation with the Level Recorder.
- 2) by using the Motor Drive UM 1018.

If frequency calibrated chart paper is used in the Level Recorder, direct plots of vibration levels (to a variety*) of logarithmic and linear scales) can be obtained against frequency. This convenient presentation of information is particularly useful for

- A. Monitoring the motion of the shaker table (section 6.3)
- B. Charting the combined frequency response of the power amplifier, shaker table and specimen (section 6.4)
- C. Recording the vibration level of some part of the specimen, i.e. to measure resonances etc. (section 6.5).

6.2. Synchronization with Level Recorder.

1) *Use of the six special scanning speeds:*

Before measuring any of these vibration levels the frequency scanning system of the 1025 must be linked and synchronized with the paper drive of the Level Recorder. There are two possibilities;

either, I, the whole system can be started and stopped manually by turning the 1025's SCANNING SWITCH,

or, II, a single sweep can be initiated by pressing the SINGLE CHART button on the Level Recorder, the system then being stopped automatically after one chart has run off.

I. Manual Stop.

- a) Insert roll of recording paper (QP 0123, QP 0423 or QP 1123) into Level Recorder. For details, see Instruction Manual for Type 2305.

*) The dynamic range of Type 2305 depends on which special potentiometer is fitted to it. A 50 dB potentiometer is delivered as standard but the following are available: 10, 25, 50 or 75 dB logarithmic; 10 to 35 or 10 to 110 linear.

6. OPERATION WITH LEVEL RECORDER

- b) On Automatic Vibration Exciter Control set
 SCANNING SPEED SELECTOR to one of the six right hand side positions
 SCANNING SWITCH "Off"
- c) Unscrew Reversing Arm (see Fig. 5.1). For clockwise scanning, leave reversing switch in right-hand position and reduce "active" frequency range by means of camdiscs (see section 5.4) if required.
- d) Interconnect Level Recorder's REMOTE CONTROL socket with the 1025's SWEEP CONTROL A as illustrated in Fig. 6.1.

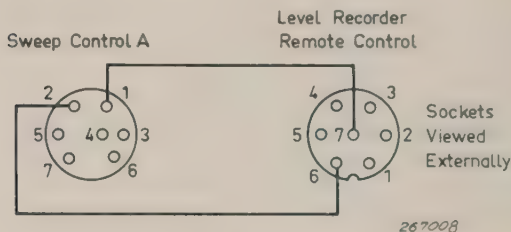


Fig. 6.1. To control the Level Recorder from the Automatic Vibration Exciter Control, connect the two instruments as shown.

- e) On Level Recorder, set
 PAPER DRIVE "Start" and "Forward"
 SINGLE CHART In upper position
 PAPER SPEED See Table VI. Use the large figures around this knob

Table VI.

Correlation between scanning speeds and paper speeds. The meaning of "pulse interval" will be clear from item k.

SCANNING SPEED SELECTOR position degrees/min.	0.864	2.59	8.64	25.9	86.4	259
Level Recorder PAPER SPEED mm/sec.	0.01	0.03	0.1	0.3	1	3
Pulse interval for 1025 drivemotor, millisecs	50.00	16.67	5.000	55.54	16.66	5.554

"Gear Lever X" (Button on right-hand end.) *Push in.*

POWER

"On"

MOTOR

"On"

- f) Set frequency pointer of 1025 to frequency where scan and record should commence.
- g) Adjust position of recording paper to Finger Wheel Z until pen covers frequency graduation corresponding to f).
- h) Start scan and paper drive by switching 1025's SCANNING SWITCH to "On".
- j) Stop at any point (less than one sweep or after several sweeps, as required) by turning SCANNING SWITCH to "Off" and METER SWITCH to "Stand By".*)
- k) Fine adjust 1025's scanning speed by the screwdriver operated Speed Trim control if required. (Located between the two SCANNING SPEED knobs). By trial and error it is possible to find a setting such that after a few sweeps the frequency pointer and the pen still agree. Alternatively, check, by means of an electronic counter that the 1025's sweep motor is being driven at exactly the right frequency. Connect the counter between chassis and pin 4 of SWEEP CONTROL B. Ideally the pulse repetition period seen here should be as given in Table VI. However, remember that the exact paper speed depends on the mains period and if this deviates from 20 msec or 16.67 msec**) the tabulated values must be adjusted accordingly.

II. Single Chart, Auto Stop.

- m) Repeat items a), b) and c) above.
- n) Following Fig. 6.2, connect Level Recorder's REMOTE CONTROL socket to a 24 V relay. A break contact on the relay then replaces a shorting link normally present on the back of the 1025's SWEEP CONTROL B socket. (Keep the other two shorting links, pins 3-6 and pins 5-7, in position).
- p) On Level Recorder, set

PAPER DRIVE	"Start" and "Forward"
SINGLE CHART	In upper position
PAPER SPEED	See Table VI. Use the small figures around this knob

*) Note: If several records are to be exactly superimposed, it is possible to run the system backwards by flicking the Reversing Switch on the 1025 to the left with a small screwdriver and moving the Level Recorder's PAPER DRIVE to "Reverse". Then stop and run forwards again. These controls must only be changed when SCANNING SWITCH is on "Off".

**) i.e. if the frequency deviates from 50 Hz or 60 Hz (The Level Recorder gears can be arranged for operation at either 50 Hz or 60 Hz).

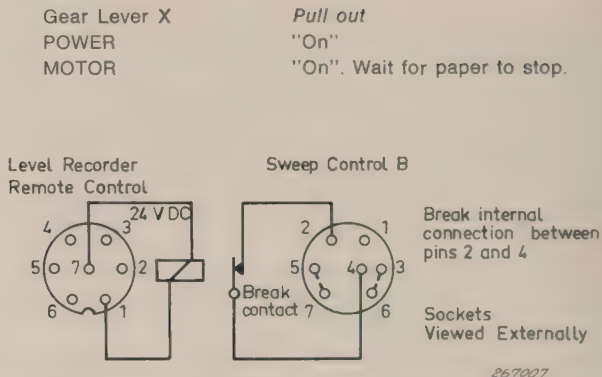


Fig. 6.2. If connected in this way, the system is started by pressing the SINGLE CHART button of the Level Recorder. Scanning stops automatically after one chart has been run off.

NOTE: Take out the interconnection (at the rear of the socket) between pins 2 and 4. The relay can, if convenient, be left coupled to the 1025 after the 7-pole plug has been removed from its socket on the Level Recorder; the 1025 is then in the same condition as when delivered.

- q) Repeat items f) and g).
- r) Turn the 1025's SCANNING SWITCH to "On". Nothing should happen
- s) Start scan and paper drive by depressing the Level Recorder's SINGLE CHART pushbutton for a few seconds, then releasing it. When the scan has stopped automatically, the 1025's frequency pointer should be in the same position as it was initially *) If it is not, follow procedure k.

2) Use of the Motor Drive UM 1018:

The Motor Drive UM 1018 has been designed for synchronous operation of the Level Recorder Type 2305 with the B & K vibration test generators. It is an external motor which is screwed onto the Level Recorder drive shaft and driven with pulses from the oscillator which also drives the sweep motor of the generator. Complete synchronism is thereby obtained in both forward and backward sweep directions, and for any number of sweep cycles.

*) When superimposing similar recordings it may be useful to back track the whole system. To do this, flick the Reversing Switch on the 1025 to the left with a screwdriver and move PAPER DRIVE to Reverse. Press SINGLE CHART and wait till the paper is back at the starting point. Do not forget to return both direction controls before recording again.

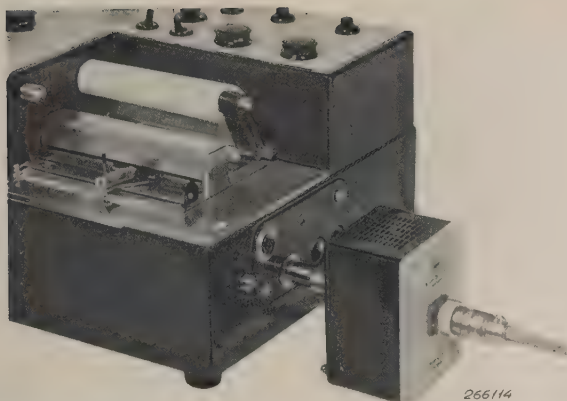


Fig. 6.3. Photograph of the Motor Drive UM 1018 mounted on the Level Recorder.

The motor is screwed onto DRIVE SHAFT II of the Level Recorder after removal of the gear wheel shown in Fig. 6.4, and connected to the generator as shown in Fig. 6.5.

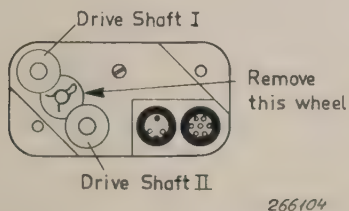


Fig. 6.4. Remove nylon gear wheel as shown.

When used with the Motor Drive UM 1018 the Level Recorder PAPER SPEED switch is set to 100 or 3 mm/sec depending upon the setting of the generator sweep speed. See Fig. 6.6. The SYNCHRONIZING GEAR LEVER on the Level Recorder is pushed in and the DRIVE SHAFT SPEED switch should be in position 120 RPM.

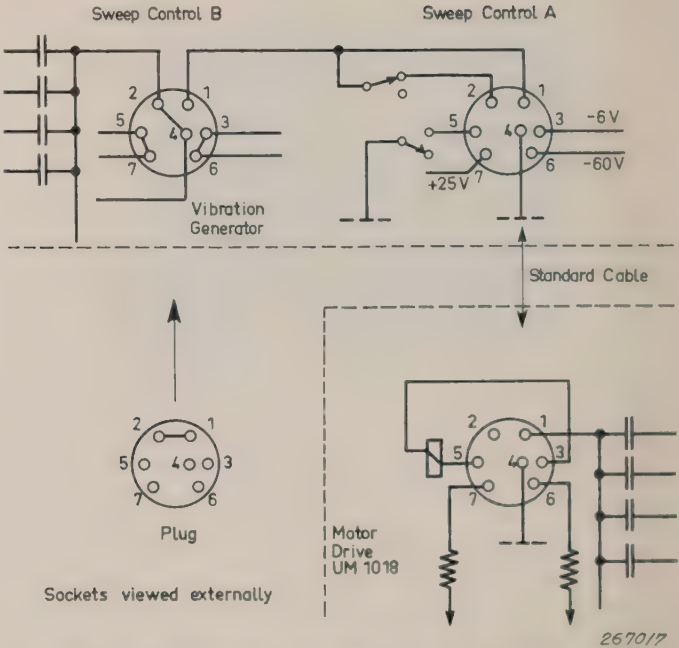


Fig. 6.5. Connection of the Motor Drive to the generator.

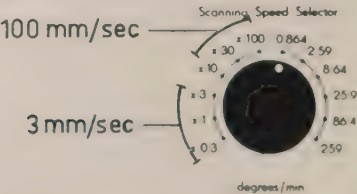


Fig. 6.6. Set PAPER SPEED on Level Recorder as indicated.

6.3. Monitoring Shaker Table Motion.

This is not always informative, since either one or two straight lines are expected if the level control is good. Nevertheless it is useful to have indisputable evidence of the test conditions. The principle is simply to run the test as described in Chapter 5 but to monitor and plot the vibration signal which is being used to control the shaker table. The arrangement is as shown in Fig. 6.7.

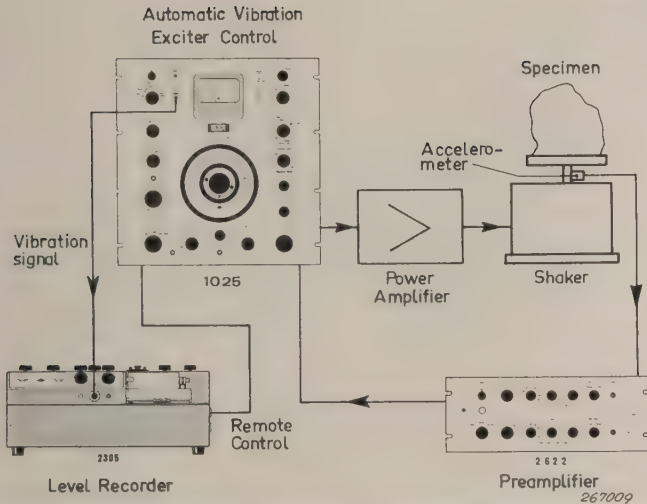


Fig. 6.7. Vibration test system coupled to a Level Recorder which plots vibration levels at the shaker table.

I. Set Level Recorder's amplifying and writing system:

POTENTIOMETER RANGE	"Stand-by"
RANGE POTENTIOMETER	Insert correct one, 10 dB, 25 dB, 50 dB, 75 dB, 10/35 Lin, 10/110 Lin.
POTENTIOMETER RANGE	Set to correspond with above, viz.: "10", "25", "50", "80", "12", "16", respectively
LOWER LIMITING	
FREQUENCY	"10 Hz"
WRITING SPEED	"40.80"
RECTIFIER RESPONSE	"RMS"
INPUT ATTENUATOR	"60 dB"
INPUT POTENTIOMETER	"0"

II. Start Scan.

In manual control case by switching 1025's SCANNING SWITCH to "On".
In single chart auto stop case by pressing the Level Recorder's SINGLE CHART button.

III. Set Plotting Level.

During a trial run adjust INPUT ATTENUATOR and INPUT POTENTIOMETER so that the ordinates of the chart can be easily related to the 1025's meter scale. (N.B. METER SWITCH on "Vibration Level").

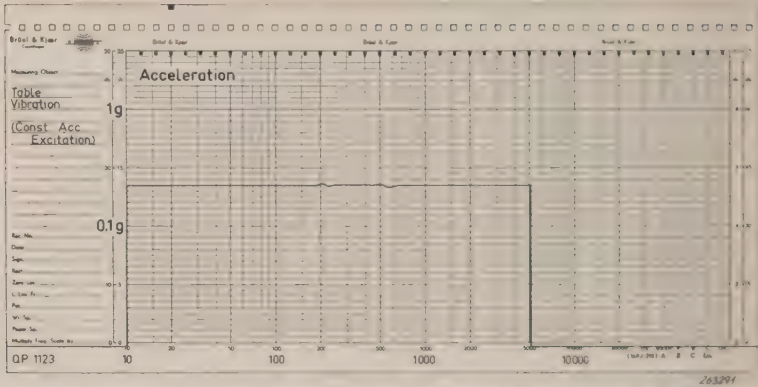


Fig. 6.8. Example of Level Recorder chart showing table vibration levels as a function of frequency. Constant acceleration control, 10 Hz to 5000 Hz.

6.4. Plotting System Frequency Response.

It is sometimes interesting to chart the open loop frequency response of the system from Exciter Control output to shaker table. There are two ways of doing this:

1. Open Loop, Measuring Table Vibration.

For safety reasons, this method is *NOT RECOMMENDED*. However, with complicated systems it can be argued that it is necessary, in which case proceed as in Fig. 6.7.

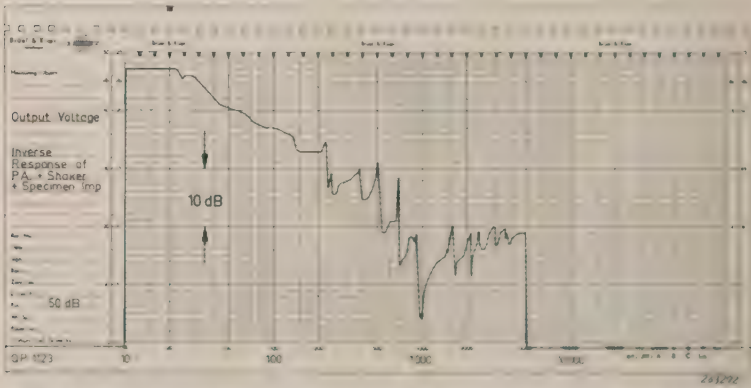


Fig. 6.9. Example of inverse characteristics of power amplifier plus shaker table. It is actually the voltage on the OUTPUT socket which is plotted here.

NOTE: Increase OUTPUT VOLTAGE *extremely carefully* and watch the vibration level at all frequencies of interest to see that, even at resonance, no damage is done. Away from resonance frequencies the vibration level will be very low.

II. Closed Loop, Inverse Characteristic.

Since the closed loop system always strives to maintain constant level at the shaker table, the inverse of the required characteristic is to be seen at the OUTPUT socket.

Therefore it is only necessary to set up the closed loop system under proper operating conditions using the same procedure as in section 6.3 but now to connect the OUTPUT socket at the back of the 1025 to the Level Recorder INPUT as well as to the power amplifier. A curve as that of Fig. 6.9 results.

6.5. Recording Specimen Vibration.

The intention here is to record the resonances of the specimen so a second transducer is required. The second channel of the Accelerometer Preamplifier Type 2622 is used for matching and calibrating the output from the monitoring accelerometer, but the signal must be amplified before being fed to the Level Recorder input*). A Vacuum

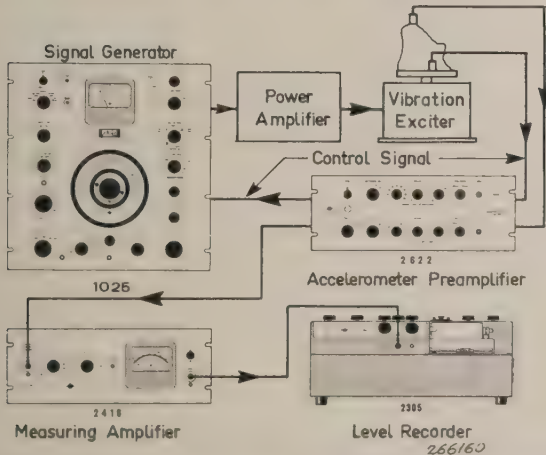


Fig. 6.10. Vibration test system in which the vibrations of the specimen are plotted on a Level Recorder.

*) If another quantity (e.g. displacement) is to be derived an amplifier with shaping networks will be needed. One solution is to route the monitor accelerometer direct to an Accelerometer Preamplifier Type 1606, which can perform one or two integrations. Type 1606 must be powered from, for instance, a Microphone Amplifier Type 2603. The latter also takes the place of the Voltmeter Type 2416.

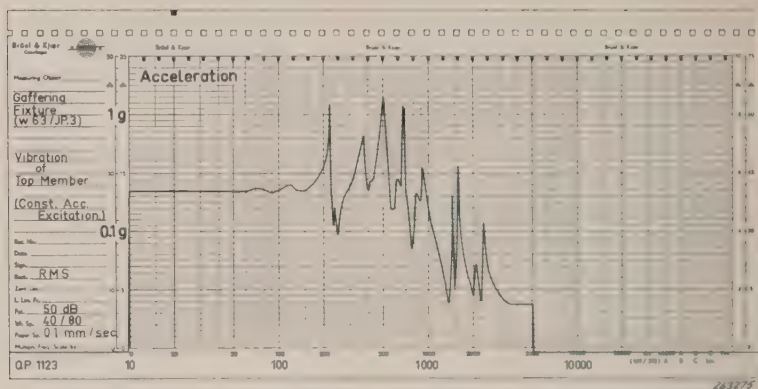


Fig. 6.11. Example of acceleration levels at the top of a specimen shaken at constant acceleration.

Tube Voltmeter Type 2416 forms a convenient calibrated amplifier for this purpose: see the arrangement of Fig. 6.10.

Follow the same procedure as in section 6.7 but this time adjust the Level Recorder's INPUT ATTENUATOR and INPUT POTENTIOMETER so that the ordinates of the chart can be easily related to the 2416 voltmeter's scale. A typical record appears in Fig. 6.11.

6.6. Recording Two Quantities Simultaneously.

Two quantities, say table vibration and specimen vibration, can be recorded "simultaneously" if the Level Recorder's Two Channel Selector is used, see Fig. 6.12.

This selector is a change over switch which is actuated from the recorder's Drive Shaft II. Set this up as described in the Level Recorder manual, using a 180° cam disc (OD 0059).

Choose a position of DRIVE SHAFT SPEED R.P.M. such that the pen has time to take up position relative first to one signal and then to the other, still maintaining resolution.

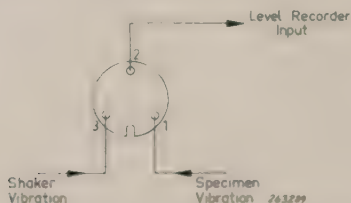


Fig. 6.12. Method of connecting the Two Channel Selector on the Level Recorder.

7. Remote Control Facilities

7.1. Start and Stop of Frequency Scan.

Connect a switch or pushbutton between pins 2 and 4 of SWEEP CONTROL B. When contact is made, the scanning system is operable.

Note: Remove interconnection normally across pins 2 and 4 of the socket. (Inside the instrument.)

This arrangement is utilized in one of the schemes for synchronizing the 1025 with a Level Recorder (Chapter 6.)

7.2. Forward and Reverse Frequency Scan.

- a. Unscrew reverse-switch arm located in the frequency dial guide plate. (See Fig. 5.1.)
- b. Set reverse-switch for anticlockwise scanning i.e. to its left hand position.
- c. Connect a pushbutton between pins 4 and 5 of SWEEP CONTROL A.
- d. Set SCANNING SWITCH to "On" position.
When operating the pushbutton i.e. closing the contact, the frequency scan will run forwards.

Warning. If the reverse-switch arm is not removed, the scanning drive will be damaged as the scan is not reversed when the finger screw for the upper frequency-scan limit reaches the arm.

7.3. Stand by.

The stand-by facility can be remotely controlled when a switch or pushbutton is connected between pins 1 and 4 of RELAY CONTROL A. By closing the contact the generator is set to stand-by.

Note: The link soldered onto the back of the socket between pins 3 and 6 must remain.

7.4. Changing Scanning Speed.

Sometimes it may be useful to scan slowly through a resonance but rapidly through the rest of the frequency range.

Method I:

If the pulse repetition frequency of an external pulse generator can be suitably programmed, feed its signal*) onto pin 2 of SWEEP CONTROL B, having broken the link to pin 4.

Method II:

- a. Set for the slower speed (through the resonance), one of the following settings of SCANNING SPEED MULTIPLIER:
 $\times 0.3$, $\times 1$, $\times 3$, $\times 0.864$, $\times 2.59$, $\times 8.64$.
- b. Wire up SWEEP CONTROL B as shown in Fig. 7.1.

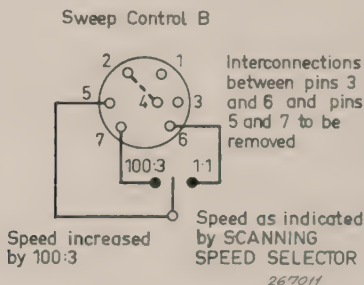


Fig. 7.1. How to increase the lower sweep speeds by a factor of 100 to 3. This is useful when "skipping" uninteresting parts of the frequency range. Note that the interconnections at the rear of the socket between pins 3 and 6 and between pins 5 and 7 must be removed.

- c. Arrange, perhaps with a switch actuated by a tuning spindle extension, that the speed changes at suitable frequencies. The faster speed (through the uninteresting sectors) is 33 times the speed indicated by the knob settings. In other words, the change is equivalent to rotating the SCANNING SPEED MULTIPLIER three clicks clockwise.

*) Chassis negative, positive-going pulses of between 4 V and 10 V magnitude to pin 2

8. Master-Slave System

8.1. Principle.

As explained in section 2.11, the outputs from all the Automatic Vibration Exciter Controls originate in the fixed and variable oscillator signals of the master unit. This is illustrated in Fig. 8.1, which also shows that the compressor loops are separate, though the compressor speeds are all switched by the master. Two slave units are shown but in principle there is no limit to the number used. In practice, however no more than three slaves should be connected owing to the risk of overloading the 6 V DC supply in the master.

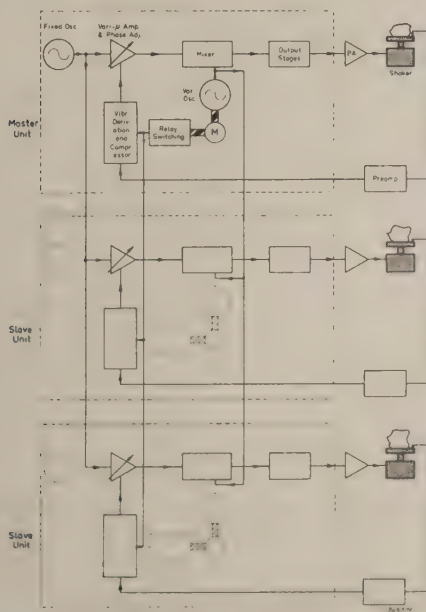


Fig. 8.1. Principle of operating several generators in parallel. Although the same frequency is fed to all shaker tables, the vibration levels can be individually adjusted.

8.2. Interconnections.

Wire up the individual systems as described in Chapter 5. In addition, interconnect the sockets of the master and of the slaves as shown in Fig. 8.2.

Keep all the 1025 units close together. Each power amplifier must be fairly near to its associated shaker so if it is necessary to space out the shakers, the long leads should be those connecting the 1025s to the power amplifiers.

The high frequency potentials of the various chassis may not be exactly equal, so to prevent transients due to relay switching etc. from influencing the output signals, it is advisable to connect all the earthy

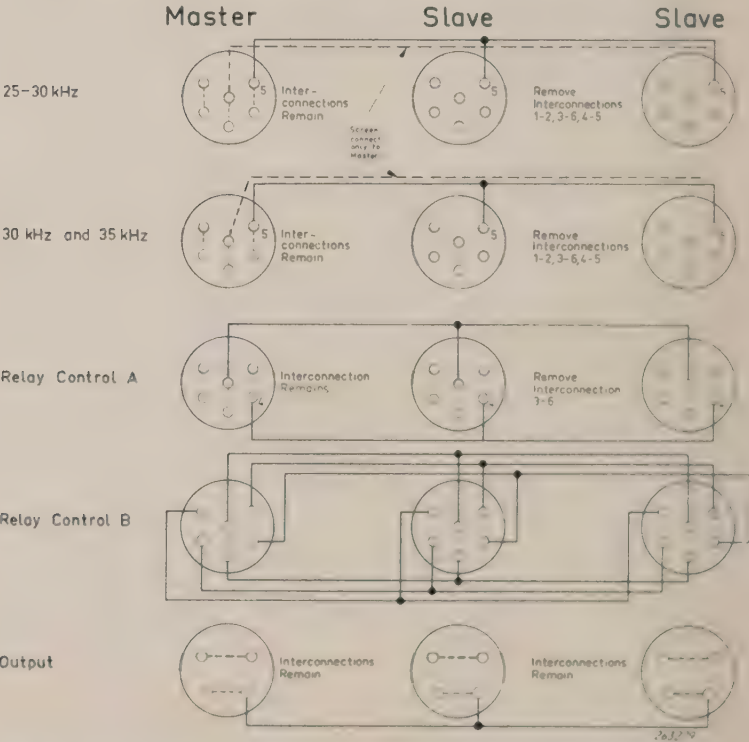


Fig. 8.2. Socket interconnections for "master-slave" system. (Viewed externally)
NOTE: Connections shown are additional to the connections for the individual systems.

pins on the OUTPUT sockets together and take them to a good ground point. Use thick short wires.

It is usually advisable to directly earth the chassis of the power amplifiers. To prevent these earths forming a ground loop via the earth point mentioned above, the power amplifiers should each be fed through a transformer (Fig. 8.3.) Provided the transformers are located in close proximity to the P.A. inputs, ordinary inexpensive input transformers may be used; their frequency characteristic is not important since any peculiarities are regulated out by the system.

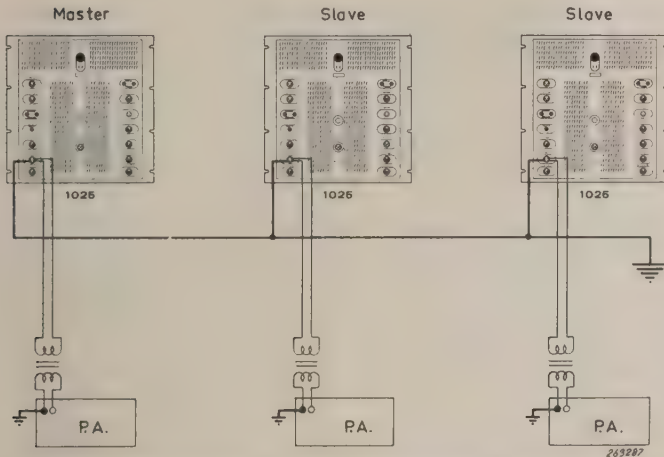


Fig. 8.3. Arrangement of earths to give minimum noise trouble.

8.3. Setting Up.

I. Set up the master unit as for an ordinary test (Chapter 5).

if one of the fixed compressor speeds is preferred, disconnect*) all RELAY CONTROL B plugs. (But keep interconnections for pins 1 and 6 when auto cross-over is needed.)

After testing the master system alone, set METER SWITCH to "Vibration Level preset" and SCANNING SWITCH to "Off".

II. Set controls on all slaves.

OUTPUT VOLTAGE	Fully anticlockwise
SCANNING SWITCH	"Off"

*) The reason is that ground loops would otherwise be formed by the various chassis earths and the relay control leads.

METER SWITCH	"Vibration Level Preset"
OUTPUT SWITCH	As required
COMPRESSOR SPEED	As used on the master
VEL. GEN. RESPONSE	As required

Frequency pointer to somewhere between 5 and 25 Hz on scale.

(Note: The pointer has to be placed within this range to avoid the compressor and cross-over relays being energized. The pointer can be locked in position by the Frequency Scanning Range stop screws.)

Cross-over point well above 25 Hz.

8.4. Adjusting Individual Vibrations (Level and Phase).

Set the vibration levels on the slave shakers, once again using the principles outlined in Chapter 5 for setting up a single system. Frequency (including cross-over) is governed by the master, but adjust each slave's OUTPUT VOLTAGE and vibration RANGE and LEVEL controls so that the vibration levels are as required not necessarily the same for all shakers. Do *not* turn any slave's SCANNING SWITCH to "On".

The desired phase relationship between the movement of the master and slave shaker tables can be adjusted on the individual master and slaves. The adjustment is effected by the screwdriver operated front panel control PHASE. The shifting range is approximately 150° on each unit, and by reversing the drive coil connections on the shaker an additional 180° phase shift is obtained.

8.5. Command of the System.

Start the automatic frequency scan of the complete arrangement by setting the master's SCANNING SWITCH to "On".

The vibration levels of all shakers can be cut down practically instantaneously by switching *the master's* METER SWITCH, to "Stand-by"*) To kill the vibration of one shaker only the OUTPUT VOLTAGE of the relevant generator is turned fully anticlockwise so that the warning lamp is switched off (the stand by cannot be used as it affects all shakers).

Any of the remote control facilities outlined in Chapter 7 can be applied to a complete master-slave arrangement. The connections must be made to the master unit.

*) It appears possible to stand-by the whole system with any of the METER SWITCHES. However, do not use this switch on any of the slaves because the stand by relay circuit then becomes grounded at more than one point, thus causing hum problems (Hum about 50 dB below maximum output voltage.)

9. Programming System

9.1. Description.

In Fig. 9.1 is shown a system which enables an advanced programming of the vibration test.

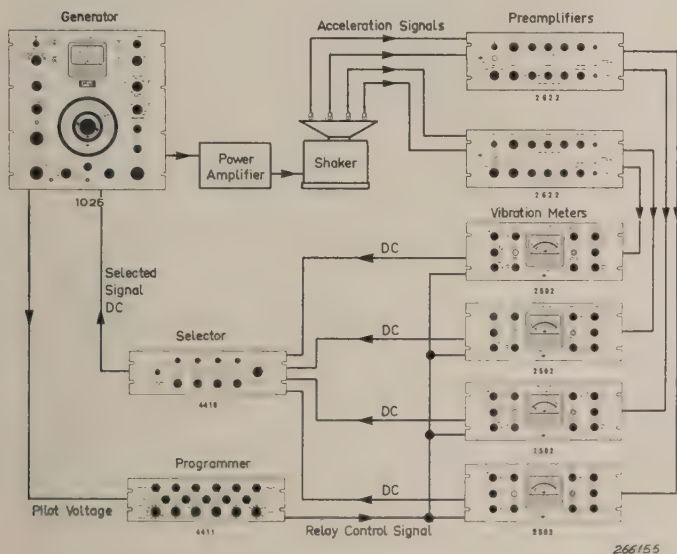


Fig. 9.1. Complete vibration test set-up.

It should be noted that this is a fairly complex system. Such a powerful set-up is not required for all types of applications. Some may only need the simple 2622 – 2502 – 1025 combination. The various possible instrument combinations are described in section 9.5.

Returning to Fig. 9.1 it is seen that the excitation signal to the shaker is supplied by an Automatic Vibration Exciter Control Type 1025 via a power amplifier. The sweep is automatic and the output signal is regulated by a feedback signal derived from the acceleration measured on the shaker table or on the specimen being tested. When the Control

Signal Selector Type 4410 is employed, it is possible to control the vibration from up to four accelerometers simultaneously. Suitable accelerometers are the B & K Piezoelectric Accelerometers Type 4332-40.

Accelerometer Preamplifiers Type 2622 are used for impedance conversion of the high impedance signals from the accelerometers. A separate instruction book is issued for the Preamplifier, where a more thorough description is given, suffice it here to say that it is a two-channel preamplifier which may be switched to operate as a charge amplifier or as a voltage amplifier, and that its outputs are scaled to 10 mV/g.

The Vibration Meters Type 2502 are used for reading the vibration at the points where the accelerometers are placed, and for supplying DC signals to the Control Signal Selector. These DC signals are proportional to the average values of the vibration quantities measured. The Vibration Meters contain integration networks for conversion of the acceleration signals to acceleration gradient (-3 dB octave), velocity (-6 dB octave) and displacement (12 dB octave), so that any of these four quantities may be measured and controlled.

The Control Signal Selector may be set to select the "Highest", the "Lowest" or the "Average" of up to four signals and will transmit the selected signal to the compressor circuit of the generator whereby the highest, lowest or average vibration is kept constant over the frequency sweep. Any one of the four signals may also be selected manually, whereby the vibration at the corresponding point is controlled.

The functioning of the Vibration Meters is controlled by the Vibration Programmer Type 4411, using a DC voltage proportional to the logarithm of the frequency from the generator sweep mechanism. Relay circuits in the Programmer are set to switch the function selector of the Vibration Meters five times in any frequency sweep, so that six frequency sub-ranges may be chosen, with control of different functions in each range. The functions available are

- Acceleration
- Acceleration Gradient
- Velocity
- Displacement
- External Filter

and a 20 dB sensitivity reduction for each function. The required function is individually pre-selected for each frequency sub-range and any combination of functions is possible.

The built-in weighting networks will be found sufficient for most applications, but for special frequency characteristics the external filter facility is a convenient feature.

An example of a combination of functions for a frequency sweep is shown in Fig. 9.2.

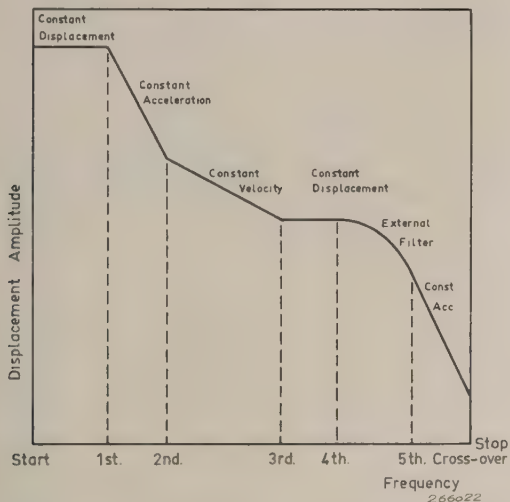


Fig. 9.2. Possible combination of functions for a frequency sweep test.

It should be noted that the system will work equally well with only two accelerometers, one Preamplifier and two Vibration Meters, as the Control Signal Selector can be used with any number of signals up to four (although its purpose may be lost if only one signal is used).

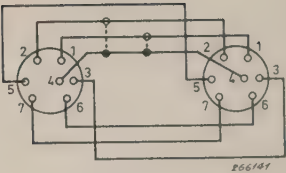
9.2. Interconnections.

If it is desirable to use the four-accelerometer control and the five cross-over frequencies provided by the programming system it is necessary to bypass the vibration meter section of the Vibration Exciter. When this is done two positions of the generator METER SWITCH cannot be used, viz. the "Vibration Level" and the "Vibration Level Preset".

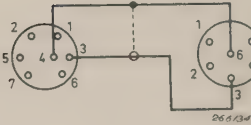
In the following the various combinations are shown schematically, and their main features are outlined. Diagrams of the relevant connecting cables are also given, to facilitate interconnection of the instruments.

The following cables are used:

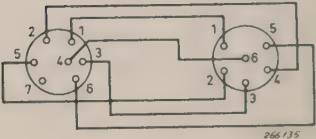
Standard



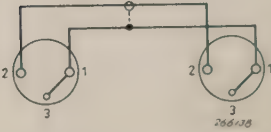
Type A



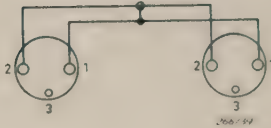
Type B



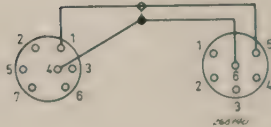
Type E



Type F



Type G



In order to simplify the illustrations somewhat, the power amplifier, shaker, test specimen and accelerometers are left out in the following combinations. (A complete system was shown in Fig. 9.1).

The cable connections in the illustrations are labelled, the upper half of the circles indicating the type of cable, and the lower half indicating the connection of the cable in accordance with the following table:

1. From DC OUTPUT of 2502 to CHANNEL INPUT of 4410.
2. From COMPRESSOR VOLTAGE of 4410 to COMPRESSOR of 1025.
The short-circuiting link between pins 2 and 3 in the COMPRESSOR socket of 1025 to be removed.
3. From VIBRATION LEVEL POTENTIOMETERS of 4410 to VIBRATION LEVEL POTENTIOMETERS of 4411.
4. From REMOTE FUNCTION SELECTOR of 4411 to REMOTE FUNCTION SELECTOR of 2502, via a connection box if there is more than one 2502.
5. From the pilot voltage output socket of 1025 to PILOT VOLTAGE of 4411.
6. From RELAY CONTROL B of 1025 to RELAY CONTROL of 2502, via a connection box if there is more than one 2502.
7. From OUTPUT A or OUTPUT B of 2622 to ACCELERATION INPUT of 2502. In order to avoid ground loops the accelerometers should be isolated from ground and each Preamplifier Type 2622 should only be grounded at one point. One E cable and one F cable are therefore used for each preamplifier as shown in the figures.
8. From VIBRATION LEVEL POTENTIOMETERS of 4410 to VIBRATION LEVEL POTENTIOMETERS of 2502. The connection between pins 1 and 3 in 2502 to be removed, and the connection between pins 1 and 7 to be changed to 3 and 7.
9. From CONTROL SIGNAL OUTPUT of 4411 to COMPRESSOR of 1025. The short circuit link between pins 5 and 1 in the COMPRESSOR socket of 1025 to be removed.
10. From VIBRATION LEVEL POTENTIOMETERS of 2502 to VIBRATION LEVEL POTENTIOMETERS of 4411.

9.3. Modification to Generator.

When connecting up the 1025 in combinations I and II below, the short-circuiting link between pins 2 and 3 of the COMPRESSOR socket should be removed. For combination III the connection between pins 1 and 5 should be removed while that between pins 2 and 3 should be kept.

9.4. Modification to Vibration Meter.

For Combination II the short-circuiting link between pins 1 and 3 in the VIBRATION LEVEL POTENTIOMETERS socket of the Vibration Meter whose potentiometers are used as external potentiometers for the Control Selector should be removed, and the connection between pins 1 and 7 should be changed to 3 and 7.

9.5. Combinations.

I.

Fig. 9.3 shows a system which utilizes the whole instrument range. There are four control accelerometers, two 2-channel preamplifiers and four Vibration Meters. Thus the vibration is controlled at up to four positions and the frequency range is split up into six subranges with individual function and level control.

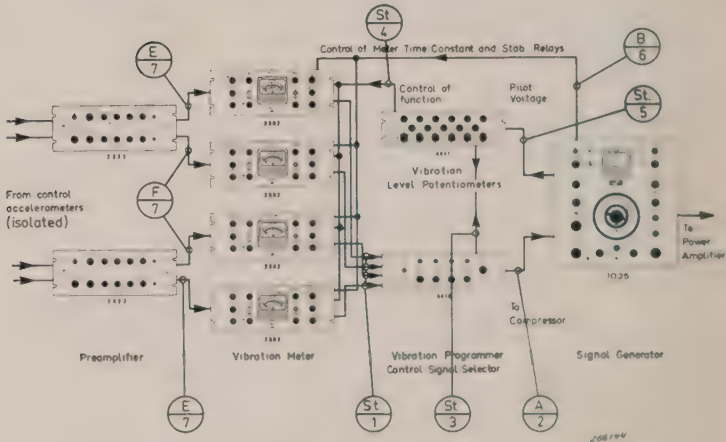


Fig. 9.3. Combination I.

II.

When the Vibration Programmer is not used, as in Fig. 9.4, only two frequency sub-ranges are possible and the cross-over is achieved with a relay in the Vibration Meter, controlled by a switch on the sweep mechanism of the Automatic Vibration Exciter Control. The cross-over may be from "Displacement" to "Acceleration", from "Velocity" to "Acceleration" or from "Acceleration" to "Acceleration Gradient". The remaining possible combinations of two functions are obtained by short-circuiting appropriate sockets at the back of the Vibration Meter.

The vibration level is controlled by the level potentiometers of the Vibration Meter whose potentiometers act as external potentiometers for the Control Signal Selector irrespective of which channel is selected, as the control signals to the Selector are taken out before the potentiometers.

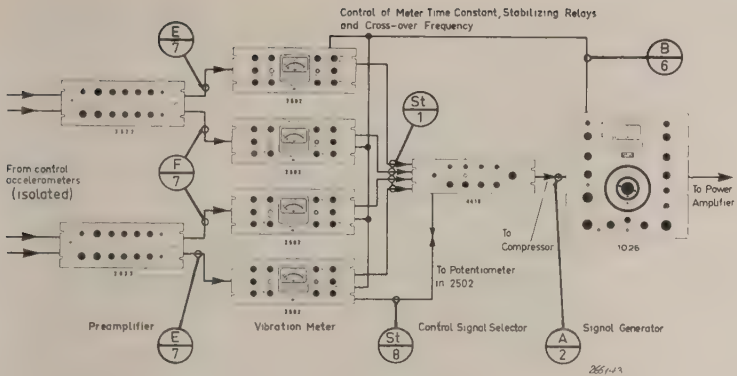


Fig. 9.4. Combination II.

III.

Leaving out the Control Signal Selector as shown in Fig. 9.5, results in a system which has five cross-over frequencies, but which employs only one control accelerometer at any one time. The Preamplifier Type 2622 has two channels, so that two accelerometers may be connected, and a switch-over from one to the other can be done automatically at some pre-selected frequency, for example by using the generator switching at 30 - 100 - 300 Hz, or the "cross-over" switch.

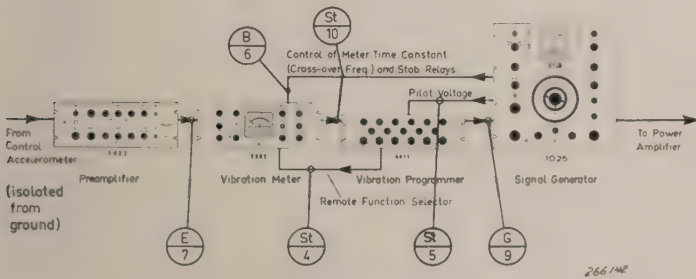


Fig. 9.5. Combination III.

9.6. Operation.

1. Connect the instruments as indicated by the relevant figure. Make sure that the voltage selector at the back of each instrument is in the correct position.

2. Turn *all* level controls and the Generator OUTPUT VOLTAGE to zero.
3. Switch on the power and allow five minutes warm-up time.
4. Set the FUNCTION SELECTOR and meter range switches of the Vibration Meters to suitable positions.
5. Tap the accelerometers gently and see that the vibration signals show up on the Vibration Meters.
6. Set the frequency pointer of the Generator somewhere in the middle of the frequency range to be employed.
7. If the Control Signal Selector is employed, set to "Highest".
8. Set the COMPRESSOR switch of the Generator to the desired position (not "Off").
9. Turn up the OUTPUT VOLTAGE of the Generator very slowly and see that the compressor loop suppresses the vibration amplitude. The deflection on the relevant Vibration Meter for Generator OUTPUT VOLTAGE turned fully on should be less than about 0.1 times full deflection. If the vibration amplitude is excessive, turn the OUTPUT VOLTAGE to zero again and locate the cause.
10. If the compressor loop is working properly, set the Control Signal Selector and the remaining control switches to the required positions whereby the testing may be started.
11. The OUTPUT VOLTAGE control of the Generator should be adjusted so that minimum compression during sweep is in the vicinity of 0 dB but not less. The amount of compression can be read on the COMPRESSOR METER of the Automatic Vibration Exciter Control

10. Conversion Charts, Tables etc.

The following table is given in order to facilitate the conversion from dB to a (voltage) ratio. It is used as follows:

Subtract a whole number of $n \times 20$ from the dB value to be converted which gives a positive remainder between 0 and 20. Look up the ratio in the table corresponding to the remainder. The value sought is then $10^n \times$ value from the table.

Example: Convert 65.3 dB re. 1 g into units of g.

$$65.3 = (3) \times 20 + 5.3.$$

5.3 gives from table 1.841. The g-value is then $10^3 \times 1.841 = 1841$ g.

With negative values the procedure is the same, e.g.:

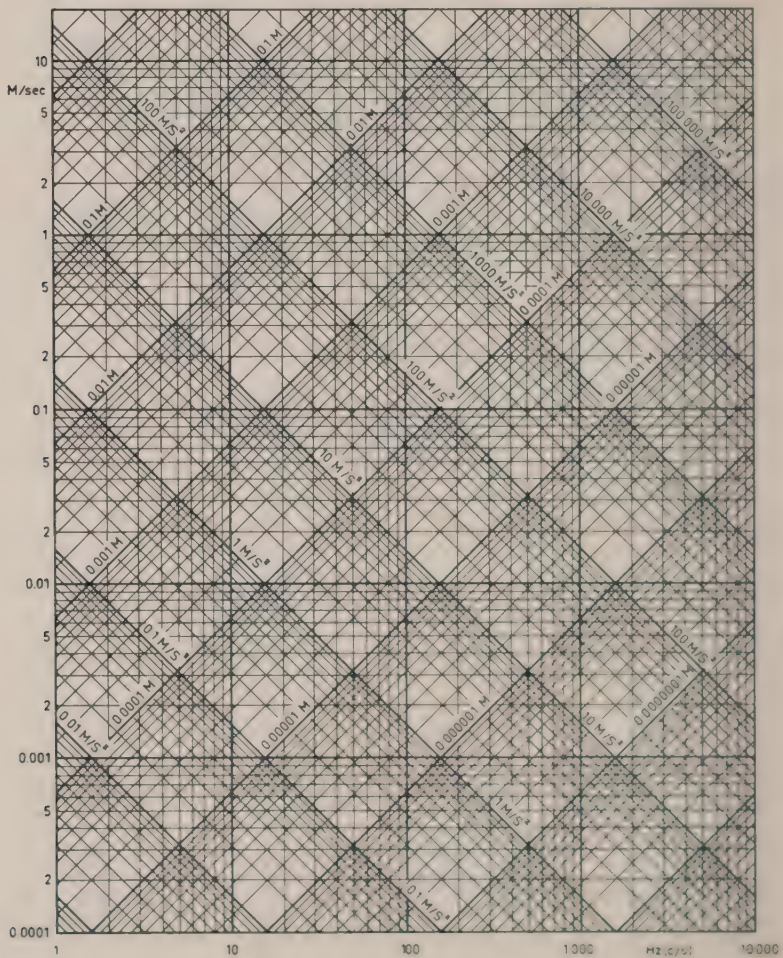
Convert -31.8 dB re. 1 g into units of g.

$$-31.8 = (-2) \times 20 + 8.2.$$

8.2 gives from table 2.570. The g-value is then $10^{-2} \times 2.570 = 0.02570$ g.

Table for Converting Decibels into (Voltage) Ratio.

dB	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
0	1.000	1.012	1.023	1.035	1.047	1.059	1.072	1.084	1.096	1.109
1	1.122	1.135	1.148	1.161	1.175	1.189	1.202	1.216	1.230	1.245
2	1.259	1.274	1.288	1.303	1.318	1.334	1.349	1.365	1.380	1.396
3	1.413	1.429	1.445	1.462	1.479	1.496	1.514	1.531	1.549	1.567
4	1.585	1.603	1.622	1.641	1.660	1.679	1.698	1.718	1.738	1.758
5	1.778	1.799	1.820	1.841	1.862	1.884	1.905	1.928	1.950	1.972
6	1.995	2.018	2.042	2.065	2.089	2.113	2.138	1.163	2.188	2.213
7	2.239	2.265	2.291	2.317	2.344	2.371	2.399	2.427	2.455	2.483
8	2.512	2.541	2.570	2.600	2.630	2.661	2.692	2.723	2.754	2.786
9	2.818	2.851	2.884	2.917	2.951	2.985	3.020	3.055	3.090	3.126
10	3.162	3.199	3.236	3.273	3.311	3.350	3.388	3.428	3.467	3.508
11	3.548	3.589	3.631	3.673	3.715	3.758	3.802	3.846	3.890	3.936
12	3.981	4.027	4.074	4.121	4.169	4.217	4.266	4.315	4.365	4.416
13	4.467	4.519	4.571	4.624	4.677	4.732	4.786	4.842	4.898	4.955
14	5.012	5.070	5.129	5.188	5.248	5.309	5.370	5.433	5.495	5.559
15	5.623	5.689	5.754	5.821	5.888	5.957	6.026	6.095	6.166	6.237
16	6.310	6.383	6.457	6.531	6.607	6.683	6.761	6.839	6.918	6.998
17	7.079	7.161	7.244	7.328	7.413	7.499	7.586	7.674	7.762	7.852
18	7.943	8.035	8.128	8.222	8.318	8.414	8.511	8.610	8.710	8.810
19	8.913	9.016	9.120	9.226	9.333	9.441	9.550	9.661	9.772	9.886



Conversion of Length:

m	cm	mm	ft	in
1	100	1000	3.281	39.37
0.01	1	10	0.0328	0.3937
0.001	0.1	1	0.00328	0.03939
0.3048	30.48	304.8	1	12
0.0254	2.54	25.4	0.0833	1

Conversion of Acceleration.

g	m/sec ²	cm/sec ²	ft/sec ²	in/sec ²
1	9.81	981	32.2	386
0.102	1	100	3.281	39.37
0.00102	0.01	1	0.0328	0.3937
0.03109	0.3048	30.48	1	12
0.00259	0.0254	2.54	0.0833	1

Conversion of Weight (Mass).

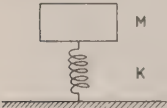
kg	gram	lbs.	oz.
1	1000	2.205	35.3
0.001	1	0.0022	0.0353
0.4536	453.6	1	16
0.02835	28.35	0.0625	1

Temperature:

$$F = \frac{9}{5} C + 32$$

$$C = \frac{5}{9} (F - 32)$$

Single Degree of Freedom System.



M = mass (kg)
 K = stiffness (Newt./m)

$\omega_n = \sqrt{\frac{M}{K}} = 2 \pi \times \text{resonance frequency}$

$\omega_n = \sqrt{\frac{g}{\delta_{st}}}$ where δ_{st} = static deflection of the mass

For Single Frequency (Sinusoidal) Vibration.

Acceleration	Velocity	Displacement
$a \cos \omega t$	$\frac{1}{\omega} a \sin \omega t$	$-\frac{1}{\omega^2} a \cos \omega t$
$-\omega v \sin \omega t$	$v \cos \omega t$	$\frac{1}{\omega} v \sin \omega t$
$-\omega^2 d \cos \omega t$	$-\omega d \sin \omega t$	$d \cos \omega t$

RMS Values.

A	$A/\sqrt{2}$	$A/\sqrt{2}$
ωV	V	$V/\sqrt{2}$
$\omega^2 D$	ωD	D

Specification

OSCILLATOR SECTION

Frequency Range:	0-5000 Hz, 5-5000 Hz and 5-10 kHz.
Frequency Scale:	Logarithmic from 5-5000 Hz.
Frequency Accuracy:	1 % $\pm$ 0.25 Hz.
Output Voltage:	Max. 10 Volts.
Max. Load:	10 k Ω //3 nF.
Output Voltage Characteristic:	Flat within $\pm$ 0.5 decibel in the frequency range 5-5000 Hz and within $\pm$ 1 decibel for frequencies between 5 and 10000 Hz. At 2 Hz: Approx. 1 dB down when unloaded and approx. 4 dB down when loaded with 10 kΩ.
Waveform:	Maximum distortion in the frequency range 5-10000 Hz 0.5 % without compressor. Maximum distortion with compressor 0.5 % for higher frequencies, and 1 % for 10 Hz at the lowest compressor speed. At 2 Hz the distortion is less than 1 % without compression and around 2 % with lowest compressor speed.
Hum Voltage:	At least 65 decibels below full output.
Constant Level Output:	1 V RMS following the frequency sweep of the generator.
Constant Level Characteristic:	Flat within $\pm$ 0.5 dB from 5-5000 Hz and $\pm$ 1 dB from 5-10000 Hz.
Distortion of Constant Voltage:	Less than 1 %.
Load of Constant Level Output:	Load should be greater than 10 k Ω //3 nF.
Signal to Noise Ratio of Constant Voltage:	Better than 45 dB.

VIBRATION METER SECTION**1. Velocity Pick-up as Controlling Element.**

Displacement Ranges: Full scale readings 0.01" (0.025 cm), 0.1" (0.25 cm), 1" (2.5 cm), and 10" (25 cm), peak-to-peak value. Accuracy $\pm 4\%$ from 10–2000 Hz. Approximately 4 % down at 5 Hz.

Acceleration Ranges: Full scale readings 1 g, 10 g, 100 g, and 1000 g (peak value). Accuracy $\pm 4\%$ from 10–2000 Hz.

Velocity Ranges: Full scale readings 0.1 in./sec. (0.25 cm/sec.), 1 in./sec. (2.5 cm/sec.), 10 in./sec. (25 cm/sec.), and 100 in./sec. (250 cm/sec.), peak value. Accuracy $\pm 4\%$ from 5–2000 Hz.

Pick-up Sensitivity: The vibration meter is adjusted for a velocity pick-up output of 96.3 mV sec. per inch. (Peak-value volts and peak-value velocity).

Pick-up Impedance: Maximum 2 k Ω .

Input Impedance: Approximately 200 k Ω .

2. Accelerometer (with Preamplifier) as Controlling Element.

Displacement Ranges: 0.01" (0.025 cm), peak-to-peak value. $\pm 4\%$ from 100 Hz to 2000 Hz. Approximately 4 % down at 50 Hz.

0.1" (0.25 cm), 1" (2.5 cm), and 10" (25 cm), peak-to-peak value, $\pm 4\%$ from 10–2000 Hz. Approximately 4 % down at 5 Hz.

Velocity Ranges: 0.1 in./sec. (0.25 cm/sec.). $\pm 4\%$ from 100 Hz to 2000 Hz; approximately 4 % down at 50 Hz. 1 in./sec. (2.5 cm/sec.), 10 in./sec. (25 cm/sec.), 100 in./sec. (250 cm/sec.). $\pm 4\%$ from 10 Hz to 2000 Hz, approximately 4 % down at 5 Hz.

Acceleration Ranges: Full scale readings 1 g, 10 g, 100 g, and 1000 g (peak value). Accuracy $\pm 4\%$ from 10–10000 Hz.

Pick-up Sensitivity: The vibration meter is adjusted for an accelerometer (preamplifier) output of 10 mV per g. (Peak-value volts and peak-value acceleration). The maximum allowable output impedance of the preamplifier is 1500 Ω .

Input Impedance:	Approximately 80 k Ω .
Meter Scale:	Semi-logarithmic. Graduated: 0-10 (Volts, g, inches, inches/sec.). 0-25 (cm, cm/sec.). -10 to +20 dB (decibels).
Monitor Output:	VIBRATION jack. Load impedance preferably more than 10 k Ω . (70 k Ω series resistor built in).

COMPRESSOR SECTION

Frequency Range:	5-10000 Hz.
Regulation Speeds:	10-30-100-300-1000 and 3000 dB/sec. Can be selected manually as a fixed speed for a complete frequency sweep, or automatically as a function of the oscillator frequency. "Switching" frequencies are: 10-100-300 and 1000 Hz. 3000 dB/sec. is not used in the automatic programs.
Dynamic Range:	60 dB. 20 dB can be compressed to 0.5 dB and 40 dB can be compressed to 1.5 dB.
Compressor Meter:	Measures the amount of compression in the range 0-60 dB.

MISCELLANEOUS

Automatic Frequency Scanning:	Built-in frequency sweep unit allows automatic scanning of any predetermined part of the frequency range. To-and-fro or uni-directional scanning. 132 different speeds. (0.3 degrees/min. to 335 degrees/min.), including six speeds enabling synchronization with the B & K Level Recorder Type 2305.
Frequency Limit Controls:	Front panel set-screw adjustment and partial blocking by means of built-in cam-discs.
Automatic Cross-over Control:	Automatic Cross-over from Displ. to Acc. or from Vel. to Acc. at any frequency between 8 Hz and 1000 Hz.

- Stand-by:** When Generator is set to stand-by the output voltage is suppressed by more than 70 dB relative to full output voltage.
- Remote Control:** Stand-by. Start-stop of automatic frequency scan. Forward-reverse changing of frequency scan. 33 to 1 scanning speed change.
- Master-Slave System:** Possible to run up to four units in parallel.

GENERAL

- Overall Stability:** Operates within stated tolerances for a mains voltage deviation of up to $\pm 10\%$. Operable up to $\pm 15\%$ mains voltage deviation.
- Power Supply:** 115-127-150-220 and 240 Volts ($\pm 10\%$). 50 Hz to 400 Hz. Power consumption 80 W.
- Tubes:** $2 \times 6AU6$ (EF94) - $4 \times 12AT7$ (ECC81) - $1 \times 12AU7$ (ECC83) - $1 \times 6BL8$ (ECF80) - $1 \times 6U8$ (ECF82) - $1 \times 6CW5$ (EL86) - $1 \times OA2$.
- Semiconductor Devices:** $2 \times TI3028$, $1 \times OC44$, $4 \times ACY20$, $1 \times 2N1671B$, $1 \times 2N2374$, $2 \times 2N3440$, $3 \times 2N3702$, $1 \times BC107$.
- Sockets:** 2 Cannon WK-C3-32S, 1 Cannon WK-4-32S, 5 Cannon WK-6-32S, 3 Cannon WK-A7-32S, 2 Telephone Jacks.
- Dimensions:** The Automatic Vibration Exciter Control can be delivered either in a wooden cabinet (Type 1025B) or for 19" rack mounting as Type 1025C.

	Type 1025B	Type 1025C
Depth	34 cm (13.5 inches)	28.0 cm (11 inches)
Height	52 cm (20.5 inches)	48.5 cm (19 ⁷ / ₃₂ inches)
Width	51 cm (20.0 inches)	48.0 cm (19 inches)

- Weight:** 30 kg (63 lbs.).

- Accessories Included:**
- 1 power cord
 - 2 telephone jacks (JP 0009)
 - 2 Cannon WK-C3-21C (JP 0304)
 - 1 Cannon WK-4-21C (JP 1004)
 - 2 Cannon WK-6-21C (JP 1005)
 - 3 Cannon WK-A7-21C (JP 0700)
 - Various panel lamps and fuses.

